# THE PLANT DISEASE REPORTER

Issued By

## THE PLANT DISEASE SURVEY

Division of Mycology and Disease Survey

BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING

AGRICULTURAL RESEARCH ADMINISTRATION

UNITED STATES DEPARTMENT OF AGRICULTURE

LIBRARY
CURRENT SERIAL RECORD
JAN 4 - 1952
U.S. DEPARTMENT OF AGRICULTURE

Volume 35 Number 12

December 15, 1951

The Plant Disease Reporter is issued as a service to plant pathologists throughout the United States. It contains reports, summaries, observations, and comments submitted voluntarily by qualified observers. These reports often are in the form of suggestions, queries, and opinions, frequently purely tentative, offered for consideration or discussion rather than as matters of established fact. In accepting and publishing this material the Division of Mycology and Disease Survey serves merely as an informational clearing house. It does not assume responsibility for the subject matter.

THE PLANT DISEASE REPORTER

Issued by

THE PLANT DISEASE SURVEY
DIVISION OF MYCOLOGY AND DISEASE SURVEY

Plant Industry Station — Beltsville, Maryland
Volume 35 — December 15, 1951 — Number 12

IN THIS ISSUE

Results of tests with various materials and methods to destroy golden nematode cysts adhering to lily-of-the-valley pips imported from Europe are reported by Julius Feldmesser, et al., page 515.

Tolerance of lily-of-the-valley pips to these treatments is reported by Henry H. Richardson and F. J. Spruyt, page 519.

A root-lesion nematode disease of narcissus, associated with a species of Pratylenchus, has recently appeared in Oregon, according to Harold J. Jensen and others, page 522.

Philip Brierley and Floyd F. Smith summarize a survey to determine virus diseases of chrysanthemums occurring in this country, page 524.

Distribution, indexing, and insect vectors in the East are given special attention in J. B. Demaree and C. F. Marcus' account of strawberry virus diseases in the United States, page 527.

Robert H. Fulton compares effectiveness of various fungicides for control of powdery mildew on red raspberry, page 538.

Tests for dewberry powdery mildew control are reported by William J. Young and Robert H. Fulton, page 540.

R. D. Watson and others report results obtained from combining various materials with heat treatment for pea and bean seed, for which heat treatment alone is not satisfactory, page 542.

A check list of diseases of economic plants in El Salvador has been prepared by Bowen S. Crandall, et al., page 545.

Isolates of the oak wilt fungus from one tree produced perithecia without being paired, according to George H. Hepting and others; they discuss significance for control of the disease, page 555.

New or unusual records, page 556, include reports on an undetermined witches'-broom of lilac in Maryland, by Philip Brierley; occurrence of citrus xyloporosis in Florida, by E. P. DuCharme and R. F. Suit; distribution of oak wilt in Michigan, by Forrest C. Strong; and determination of Ascochyta blight of cotton in Texas, by L. S. Bird.

October weather, page 558.

# INVESTIGATIONS ON CONTROL OF THE GOLDEN NEMATODE OF POTATOES

Julius Feldmesser, George Fassuliotis, and F. J. Spruyt

The golden nematode of potatoes, Heterodera rostochiensis Wollenweber 1923, a serious pest of the potato and the tomato is, at present, confined to only one area of the United States: the two counties comprising Long Island, N.Y. In 1941, Long Island was designated a quarantine area by the U. S. Bureau of Entomology and Plant Quarantine to safeguard the rest of the country from the spread of this plant parasite. The quarantine is still in effect and in addition, quarantine regulations forbid the importation of any plant or other material containing cysts of this nematode. In November 1949, European shipments of lily-of-the-valley pips (Convallaria spp.), with golden nematode cysts adherent to but not parasitic on the roots, were intercepted at the Port of New York by the Division of Foreign Plant Quarantines, U. S. Bureau of Entomology and Plant Quarantine, Hoboken, New Jersey. These pips were intended for shipment to growers in all parts of the country. To avoid the spread of the nematode throughout the country, a cooperative project was initiated to secure data for treatments that would prove lethal to the contents of the nematode cysts and at the same time be tolerated by the plant materials. Convallaria pips so treated might then be imported without danger. Treatments for the control of the nematode were carried out by the Division of Nematology, U. S. Bureau of Plant Industry, Soils, and Agricultural Engineering, Hicksville, New York and the results are reported herein[1]. Tolerance of the plant materials to treatments was studied by the Division of Control Investigations, U. S. Bureau of Entomology and Plant Quarantine, Hoboken, New Jersey and the results are reported in another paper in this journal.

## PROCEDURE

Exploratory treatments were made in four categories: chemical dips, vapor heat treatments, methyl bromide and hydrogen cyanide fumigation, and hot water dips. These treatments were investigated for their effects against cysts (i.e., dead Heterodera rostochiensis females containing viable, hatched or unhatched larvae). To secure a supply of cysts, infested soil was removed from the laboratory field at Hicksville, washed through a U. S. Standard no. 60 sieve and concentrated so that one gram of the resulting material contained approximately 1200 cysts mixed with organic chaff matter. One-gram lots of this material were enclosed in small nylon bags and treated as described herein.

After treatment, each lot of cysts was stored in a constant temperature chamber at 70°F., then divided into two parts and examined for viability at periods varying from three to four weeks after treatment. One half of each lot was examined under a binocular dissecting microscope and the numbers of cysts containing viable and non-viable larvae counted. A cyst was counted as having viable larvae if one or more larvae remained alive in it after treatment. When there was doubt as to viability, immotile larvae were stimulated in the region of the circumoesophageal nerve ring by stroking with the shaft of a fine needle or with a bamboo splinter; invariably, viable larvae showed some motility after this stimulation. The second half of each lot was placed in potato root leachings[2] in order to stimulate hatching, and checked twice weekly for evidences that this had occurred.

## TREATMENTS

### CHEMICAL DIPS:

Cysts in bags were dipped, for five-minute periods at room temperatures, in water solutions of the following substances, the proportion of the chemical to water being as indicated: Semesan Junior, 1:500 parts; Botonone, 1 oz. per gallon and 2 oz. per gallon; Dowicide G, 1:1000 and 1:2000 parts; Dowicide 7, 1:2000 parts; iodine, 1:5000, 1:10,000 and 1:100,000 parts; Parathion, 1:2000 and 1:3000 parts; E-605, 1:2000 parts; Ceresan NF, 1:500 parts; and Dowicide 2, 1:2000 parts.

In addition, two series of cysts washed, one being washed after exposure and one not, were dipped in Dowicide 2, 1:2000 and 1:4000 parts at 60°F., 70°F., and 90°F. for periods of 4, 5, and 6 minutes. Another series was dipped in 0.5% formalin at 85°F. and at 95°F. for 10 minutes. At

[1]Acknowledgment is made to Henry Lange and to Joyce von Mechow for their aid in certain parts of the study.

[2]O'Brien, D.G. and E.G. Prentice, 1931. A nematode disease of potatoes caused by Heterodera schachtii (Schmidt). W. of Scotland Agric. Res. Bull. No. 2.

the end of the designated exposure periods, the bagged cysts were removed from the solutions, allowed to dry in the bags without washing unless otherwise stated, and then stored.

VAPOR HEAT:

Cysts in bags were exposed to vapor heat for specified periods ranging from 30 minutes to one and one-half hours at various temperatures from 112°F. to 120°F.

FUMIGATION:

As has been demonstrated[3], cysts collected from soil in the winter are more resistant to treatment than those collected in the summer. It was therefore decided to use both types of cysts in the tests. The summer cysts had been collected from Long Island fields during the previous summer and thereafter maintained at 70°F.; the winter cysts had been collected from Long Island fields during December 1949 and thereafter maintained at 40°F. An average of 30 percent of both types of cysts was found to contain viable larvae.

Two fumigants were tested for efficacy against one-gram lots of cysts of both categories in fumigation chambers, the procedure being as follows: Material was placed in the fumigation chamber and air removed to form a partial vacuum where specified. Degree of vacuum is expressed as the percentage the normal atmospheric pressure was reduced in the chamber by the vacuum pump. Ten tests were made using hydrogen cyanide gas: 0.33 lb. per 1000 cubic feet for one hour, three replications at 50% vacuum and two replications at 90% vacuum; 0.5 lb. per 1000 cubic feet for one hour, two replications at 50% vacuum; and 1 lb. per 1000 cubic feet for one hour, two replications at 50% vacuum and one test at 90% vacuum. Twenty-two tests were run using methyl bromide: one at 1 lb. per 1000 cubic feet for 16 hours at normal atmospheric pressure; one at 2 lb. per 1000 cubic feet for four hours at 90% vacuum; one at 2 lb. per 1000 cubic feet for eight hours at normal atmospheric pressure; one at 3 lb. per 1000 cubic feet for four hours at 90% vacuum; two at 4 lb. per 1000 cubic feet for four hours at 50% vacuum; six at 4 lb. per 1000 cubic feet for four hours at 90% vacuum; eight at 4 lb. per 1000 cubic feet for four hours at normal atmospheric pressure; one at 5 lb. per 1000 cubic feet for four hours at 90% vacuum; and one at 11 lb. per 1000 cubic feet for eight hours at normal atmospheric pressure. In addition, a treatment recommended by Sebelin[4] as lethal was run in six replications: 4.33 lb. of methyl bromide per 1000 cubic feet for two hours at normal atmospheric pressure. Fumigation chambers containing bagged cysts were exhausted of the fumigant at the end of designated exposure periods and the bags of cysts were stored to await examination.

HOT WATER:

An exploratory series of treatments using a Fisher hot water bath equipped with a thermoregulator was made in January 1950 and additional work on promising treatments was done during the period February-June 1950. The bagged cysts, both summer and winter types, were pre-wet to insure escape of air from them and were then immersed in hot water at the temperatures and for the times specified. The bags of cysts were placed in water at room temperature immediately after the exposure periods, allowed to dry, and then stored at 70°F. The following treatments were run: 110°F. for 45, 60, 90, 120 and 180 minutes; 112°F. for 45, 60, 90, 120 and 180 minutes; 114°F. for 45, 60, 90 and 120 minutes; 116°F. for 40, 45 and 55 minutes; 118°F. for 25, 30, and 40 minutes; 120°F. for 25 and 30 minutes; 125°F. for 10 minutes; and 130°F. for 5 and 10 minutes. Later work included three replications at 116°F. for 45 minutes, three replications at 118°F. for 30 minutes, one test at 119°F. for 30 minutes, three replications at 120°F. for 25 minutes, and 14 replications at 120°F. for 30 minutes.

## RESULTS

CHEMICAL DIPS:

The treatments with 0.5% formalin at both temperatures resulted in a total kill of larvae in the nematode cysts. Dowicide 2, 1:2000 parts, also killed all of the larvae, but was apparently adsorbed by materials placed in its solution, for the bags and cysts that were washed immediately after exposure to the chemical retained as heavy an odor of the chemical as the unwashed bags

[3]Feldmesser, J. and G. Fassuliotis, 1950. Reactions of the golden nematode of potatoes, Heterodera rostochiensis Wollenweber, to controlled temperatures and to attempted control measures. Jour. Wash. Acad. Sci., 40: 355-361.

[4]Dr. Christian Sebelin, Staatsinstitut für Angewandte Botanik, Hamburg, West Zone of Germany, in private communication to the Bureau of Entomology and Plant Quarantine.

and cysts, indicating that the exposure time to this substance was actually much longer than that given above. Furthermore, one lot of cysts exposed to a solution that had been used, previously, to treat several bundles of lily-of-the-valley pips, showed a reduction in viability of only 98 percent. It is doubtful that the maintenance of a lethal concentration of Dowicide 2 in solution is possible without continuous checking and addition of the concentrate to the solution.

No other chemical dip tested killed all of the larvae in the cysts.

VAPOR HEAT:

One of the series of vapor heat treatments appeared to be lethal to the contents of the cysts, 115°F. for one hour, but this treatment was not rechecked because of the impracticability of using vapor heat in large scale operations.

FUMIGATION:

Hydrogen cyanide gas, at the dosages and exposure periods tested, produced no significant reduction in viability of nematode cyst contents.

The treatment recommended by Sebelin, 4.33 lb. of methyl bromide per 1000 cubic feet for two hours, was not efficient. This treatment resulted in only a 50 percent reduction in viability of the summer cysts and a 16.7 percent reduction in viability of the winter cysts.

With other methyl bromide treatments, also, the reactions of larvae in winter cysts differed from those in summer cysts. Sixteen tests were made with 4 lb. per 1000 cubic feet for four hours since this treatment seemed to be the heaviest that the plant material would tolerate. The winter cysts showed greater resistance to this treatment than the summer cysts. Controls had an average of 30 percent of cysts containing viable larvae. An average of 23.8 percent of the winter cysts contained viable larvae after exposures of four hours to 4 lbs. per 1000 cubic feet at normal atmospheric pressure, at 50% and at 90% vacuum. This represents a 20.7 percent kill. On the other hand, an average of only 2.6 percent of the summer cysts had viable contents after exposure to the same treatments, the kill, when compared to the control, being 91.3 percent. Also the 1 lb. of methyl bromide per 1000 cubic feet for 16 hours at normal atmospheric pressure, lethal to all the larvae in summer cysts, allowed some survival in the winter cysts (0.001 percent). The larvae from cysts exposed to these sublethal treatments were judged to be viable when they were stimulated by stroking in the region of the oesophagus. They did not, however, respond to the stimulatory effect of potato root leachings over a two-week period.

The only methyl bromide treatment tried that was judged to be efficient for kill of contents of both summer and winter cysts was the 11 lbs. per 1000 cubic feet for eight hours at normal atmospheric pressure. This treatment results in complete disintegration of the larvae.

HOT WATER:

Also, larvae in winter cysts showed higher resistance to hot water treatments than those in summer cysts. Invariably, exposures that resulted in complete kills in summer cysts (114°F. for 90 minutes, 116°F. for 40 minutes, 118°F. for 25 minutes, 120°F. for 25 minutes) allowed some survival in the winter cysts. Treatment at 116°F. for 45 minutes, judged to be effective by Triffitt and Hurst[5], was found not to be a dependable treatment. Two replications contained viable larvae of both categories and two replications contained no viable larvae.

Three replications of 120°F. for 25 minutes revealed this treatment to be unreliable. Larvae in winter cysts survived in all three.

The following treatments were judged to be lethal to larvae in both summer and winter cysts, on the basis of both microscopic examination and reaction to potato root leachings, those at 116°F. and 118°F. being doubly checked, and that at 120°F. being replicated fourteen times:

| | |
|---|---|
| 112°F. - three hours | 118°F. - 30 minutes |
| 114°F. - two hours | 120°F. - 30 minutes |
| 116°F. - 55 minutes | 125°F. - 10 minutes |

## CONCLUSIONS

The following treatments were found to be lethal to the contents of cysts of the golden nematode:

[5] Triffitt, M. J. and R. H. Hurst. 1935. On the thermal deathpoint of Heterodera schachtii. Jour. Helm., 13: 219-223.

1. Dowicide 2, 1:2000 parts, for four minutes at 60°F., but there was apparently some difficulty in maintaining this concentration in solutions.
2. 0.5% formalin for 10 minutes at 85°F.
3. Methyl bromide, 11 lbs. per 1000 cubic feet for eight hours at atmospheric pressure.
4. Hot water at 112°F. for three hours, 114°F. for two hours, 116°F. for 55 minutes, 118°F. for 30 minutes, 120°F. for 30 minutes, and 125°F. for 10 minutes.

In some sublethal treatments with both hot water and chemicals, a higher proportion of larvae survived in winter cysts than in summer cysts.

DIVISION OF NEMATOLOGY, BUREAU OF PLANT INDUSTRY, SOILS AND AGRICULTURAL ENGINEERING, U. S. DEPARTMENT OF AGRICULTURE, HICKSVILLE, NEW YORK

# QUARANTINE TREATMENTS TO CONTROL GOLDEN NEMATODE CYSTS ADHERING TO LILY-OF-THE-VALLEY PIPS: PROGRESS REPORT WITH SPECIAL REFERENCE TO PLANT TOLERANCE

Henry H. Richardson and F. J. Spruyt[1]

Plant nematode pests can be spread not only on their specific host plants but also on other nonhost plants or material in which they become physically entangled. Thus viable cysts of the golden nematode of potatoes, (Heterodera rostochiensis Woll.) were intercepted in November 1949 by foreign plant quarantine inspectors of the U. S. Bureau of Entomology and Plant Quarantine among the roots of lily-of-the-valley pips (Convallaria sp.) imported from Germany through the port of New York. The cysts were adhering to but were not parasitic on the roots, and could not be entirely removed by repeated washings. Apparently the pips had been grown in soil recently used for potato production. A project was started immediately by the Bureau of Entomology and Plant Quarantine, in cooperation with the Bureau of Plant Industry, Soils, and Agricultural Engineering, in an effort to develop a treatment that would destroy these cysts and permit the distribution of the pips in the normal channels of trade without disseminating this dangerous pest.

The present summary of the reaction of pips to various treatments is a progress report on approximately 600 experimental tests and 38 large-scale treatments involving over 350,000 pips, made from November 1949 to November 1950. The treatments were made at the Plant Quarantine Inspection House at Hoboken, New Jersey, and the pips were forced at the greenhouse of the Nematode Research Laboratory at Hicksville, New York, within the quarantine area[2], or at other cooperating greenhouses. The tests for lethality of the treatments to the cysts, which are reported in a separate paper in this same journal, were usually made in conjunction with the treatment of the pips.

Lily-of-the-valley pips for export from Germany are tied into bundles of 25 pips each after harvest, packed in wet sphagnum moss, and shipped to the United States under refrigeration at 28° to 30°F. They are kept solidly frozen for periods of one month up to a year or more until desired for forcing by the growers. The methods of treatment tried after thawing included heat treatments of these bundles by immersion in hot water and by exposure to vapor heat; fumigation with methyl bromide, hydrocyanic acid gas, or acrylonitrile; and chemical dips of compounds known or suspected as toxic to the cysts. The tolerance of the plants to all these treatments was judged mainly by the subsequent growth of the leaves and flowers, especially the latter. Flowers were graded into (a) fancy, (b) first grade, (c) second, or utility, grade, and (d) injured, depending on the height of the stem, and the number, size, and quality of the bells.

## HEAT TREATMENTS:

Immersion in hot water of 118°F. for 30 minutes has been the most promising treatment thus far, and has been fairly well tolerated by the pips. A hot-water treatment of 132° for 5 minutes, recommended for potatoes[3], was too drastic and caused stunting of both the leaves and flowers. Temperatures of 130° for 10 minutes, 125° for 20 minutes, 116° for 55 minutes, 115° for 90 minutes, 114° for 120 minutes, and 112° for 180 minutes were likewise injurious. The pips showed some tolerance to cyst-killing exposures to vapor heat, but its penetration into the densely bunched roots was so slow that studies along this line were abandoned.

## FUMIGATION:

Methyl bromide fumigation at the dosages recommended by scientists at Cornell University for the disinfestation of potato bags -- i.e., approximately 45 pounds per 1000 cubic feet for two hours, or 22 1/2 pounds for 16 hours -- caused complete kill of the pips. The maximum dosage schedule tolerated by the pips at 60° to 65° appeared to be near 3 pounds for four hours at normal atmospheric pressure. Cold pips at 35° were more tolerant than warm pips at 65°. Freshly im-

[1]Acknowledgement is made to J. W. Bulger, who conducted a number of the experimental fumigations, to G. C. Siebrecht, H. Roth, and H. Lange, for their aid in making the tests, and to B. Phillipo, Paul Bruns, McHutchison & Co., and other importers for their cooperation.

[2]Popham, W. L. 1949. The golden nematode invades New York. Smithsn. Inst. Rpt. 1948, pp. 349-354.

[3]DuMond, C. D. 1949. Golden nematode quarantine No. 5, Official Order. N. Y. State Dept. Agr. and Markets, April 6, 1949.

ported pips were thawed and warmed to 65°, fumigated with 4 pounds for two hours, then refrozen and stored for three months at 28° to 30° before forcing, with little or no injury to the plants and flowers. A dosage schedule recommended by Sebelin[4] of approximately 4 1/3 pounds for two hours at 70° was also tolerated by the pips but proved ineffective against the cysts.

Dosages of an acrylonitrile-carbon tetrachloride mixture and of hydrocyanic acid gas tolerated by the pips were not effective against the cysts. A 50:50 mixture, by volume, of acrylonitrile and carbon tetrachloride caused complete kill of the pips at dosages of 3.3 up to 20 pounds per 1000 cubic feet for four hours at 65° to 70°. Convallaria pips tolerated dosages of hydrocyanic acid gas up to 1/2 pound per 1000 cubic feet for one hour in a 15-inch sustained vacuum, but dosages of 1 pound caused considerable stunting and 2 and 3 pounds caused severe injury or complete kill.

CHEMICAL DIPS:

None of several chemical dips (usually five minutes at 75°F.) proved promising, as the limits of tolerance were below the point where cyst mortality was complete. B. Lear, of Cornell University, suggested the trial of several chlorophenols. However, a five-minute dip in a 0.05% water solution of 95% trichlorophenol (Dowicide 2) caused severe stunting and injury to the pips. At 0.025% strength the flower crop was fair. Injury still resulted from the 0.05% solution even when the pips were washed with water for one to five minutes immediately after the dipping, and only 10 to 40 percent of them produced commercial flowers. The pips apparently removed considerable chemical from the solution, for there was little or no plant injury after the dip had been used twice. Refreezing and storing the treated pips for one to four months appeared to increase plant injury to some small extent.

A 1% emulsion of pentachlorophenol caused severe plant injury. A fair crop of flowers was produced after the pips were dipped in a 0.5% emulsion of pentachlorophenol, or a 0.5% or 1% solution of sodium pentaphenate.

Franklin[5] reported 5% formaldehyde effective against the cysts in three-hour dips at near 75°F. However, formaldehyde dips caused severe stunting of lily-of-the-valley in the following treatments: 5% solution for 5 hours at 75° or for 1/2 and 1 hour at 90°, 0.5% for 5 or 15 minutes at 118°, or 0.185% for 30 minutes at 118°. The last is the usual concentration used in bulb treatments in the Pacific Northwest. Injury occurred even when the pips were dipped in fresh water for one minute following treatment.

Pips treated with parathion at concentrations of 0.06% and 0.033% produced fair to good crops of flowers -- 84 to 95 percent, respectively. Refreezing and storage after treatment increased the injury slightly.

Iodine at 0.001% to 0.02% was well tolerated even when treated pips were refrozen for one to four months before forcing. One-percent ethyl mercury phosphate (Semesan Jr.) diluted 1 to 500 gave fair flower crops, but a 5% strength (Ceresan N.F.) diluted 1 to 500, and 5% phenol caused severe injury.

PRACTICAL APPLICATION OF THE HOT-WATER TREATMENT:

Immersion in hot water at 119° to 120°F. for 30 minutes was suggested as an emergency treatment in February 1950, and more than 300,000 1949 pips were treated prior to November 1950. In February there was little difference in growth, but from April through November there was a slight stunting and delay; however, this was not serious enough to prevent production of a commercial crop of flowers (Fig. 1).

In additional tests made from January to May 1951, the treatment caused more serious stunting on 1950 stock, particularly if grown afterwards on a cold 55° to 60° bench. The margin of tolerance to the heat treatment is very small. It now appears that the treatment should be relaxed to 118°F. for 30 minutes. Further tests with the cysts embedded in actual bunches of pips indicated that this treatment would be completely effective, and flower crops appeared only slightly reduced from those of untreated checks. This treatment is a drastic one for Convallaria pips but it appears to be the best of those tried. Every lot of pips varies slightly from others, and the latest work indicates that the condition of growth and the bench and air temperature are important.

---

[4]Communication from Christian Sebelin, Staatsinstitut für angewandte Botanik, Hamburg, Germany, to the U. S. Bureau of Entomology and Plant Quarantine, Feb. 22, 1950.

[5]Franklin, Mary F. 1939. The treatment of seed potatoes for destruction of adherent Heterodera schachtii cysts var. solani. Jour. Helminthol. 17(2): 113-126.

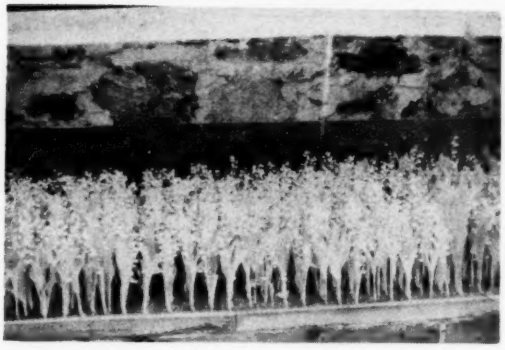


FIGURE 1. Lily-of-the-valley flower crop, June 6, 1950, from pips treated with hot water (120°F.) for 30 minutes on May 16, 1950. The better leaf production on pips at the right is apparently due to variation in the stock. The leaf production on pips at the left (foreground) is satisfactory for commercial purposes. About 93 percent of the pips produced a commercial crop of flowers.

The following procedure has been used at the Plant Inspection House at Hoboken, N.J. The pips are thawed for approximately one day in summer or for one to two days in winter. The bunches are separated from the sphagnum moss and packed rather closely into wire-mesh baskets. No prewarming is necessary, but the water temperature is prevented from dropping below 118°F. by the addition of sufficient steam to offset the cooling effect of the load of pips. After the 30-minute immersion, the pips are drained for five minutes. This drain period, in which temperature loss is slight, compensates for the time needed at the start for the heat to penetrate into the center of the bunches. After drainage, the pips are hosed or dipped for five minutes in cool water near 50° to 60° to bring the temperature down uniformly, before being repacked. The boxes and sphagnum moss are treated separately by steam sterilization. The pips should be planted within three to four days or else the sprouts will be injured in the tightly packed boxes. Present indications are that treated pips must be handled more carefully than untreated pips. Forcing beds should be kept near 65° to 70° and the plants should be given top light gradually two or three days earlier than usual, allowed to harden gradually, and not exposed to strong drafts.

Refreezing and storage of pips after hot-water treatment has caused considerable injury. Pips that had started to sprout were injured by hot-water treatment, this injury ranging from moderate stunting on slightly sprouted pips to severe stunting and total loss of flowers where pips had sprouts 1 to 2 inches long. Larger pips with heavier roots appeared to withstand the treatment better.

DIVISION OF STORED PRODUCT INSECT INVESTIGATIONS, BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE; DIVISION OF NEMATOLOGY, BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING.

# A ROOT-LESION NEMATODE DISEASE OF NARCISSUS[1]

Harold J. Jensen, C. G. Anderson and J. Wieman[2]

Narcissus bulb growers in Oregon have recently noticed a premature yellowing, falling and withering of the foliage in certain areas of their King Alfred fields (Fig. 1, A and B)[3]. The starvation-like symptoms were observed in late spring and early summer when normally the plants should be growing vigorously. The foliar symptoms appear to move progressively from the old to the new leaves. In most cases bulbs produced by plants growing in the infested areas failed to size properly (Fig. 1, C). Some growers pointed out that bulbs taken from these zones were even smaller than the original planting stock. The most noticeable effect of the disease was that the infested plants possessed only a few roots in the late spring when the root systems of normal plants were well developed. Nearly all of the remaining roots were short and stubby due to a girdling or dieback condition (Fig. 1, D).

A microscopic examination of the aborted roots showed that they contained numerous nematodes in all stages of development along the margin of the healthy and necrotic tissue (Fig. 1, E). Although this area contained a few saprophytic forms, most were parasitic belonging to an apparently undescribed species of meadow or root-lesion nematodes Pratylenchus sp. The fungus, Cylindrocarpon sp., was also recovered from numerous tissue isolations taken from roots of diseased plants.

According to Gerretsen et al. (2), a disease with similar symptoms has been observed in Holland since 1917. The symptoms of the disease reported by these authors are very similar to those observed in Oregon. Feekes (1) and Van Hell (4) isolated Cylindrocarpon radicicola Wr. and Fusarium sp. from the diseased roots. Hastings, Newton and Steiner (3) observed a similar disease on narcissus in British Columbia, Canada. They isolated the fungus, Cylindrocarpon, and various nematodes including Tylenchus pratensis from the short-root stubs that remained attached to the bulbs of diseased plants. In conclusion they stated, "The existence of this Tylenchus in the roots of narcissi is new, but fully explanatory for the diseased condition of these bulbs ..... In the present case, it is thought to be the primary cause of the "Root Decline", while the other nemas and the fungus are secondary." The nematode referred to as Tylenchus pratensis is probably very similar to the form found in Oregon. Meadow or root-lesion nematodes were formerly included in the genus Tylenchus until 1934, when Filipjev placed them in the genus Pratylenchus.

The "Root-Lesion Nematode Disease of Narcissus" has reappeared in the same areas even though a two- or three-year rotation plan had been practiced. At the present time the disease has been observed in two of the major bulb producing areas of Oregon. While the foliar symptoms are probably specific when they occur in late spring or early summer, a positive diagnosis of the disease depends upon the recovery of root-lesion nematodes from the root tissue. Investigations of possible control measures are now in progress.

## Literature Cited

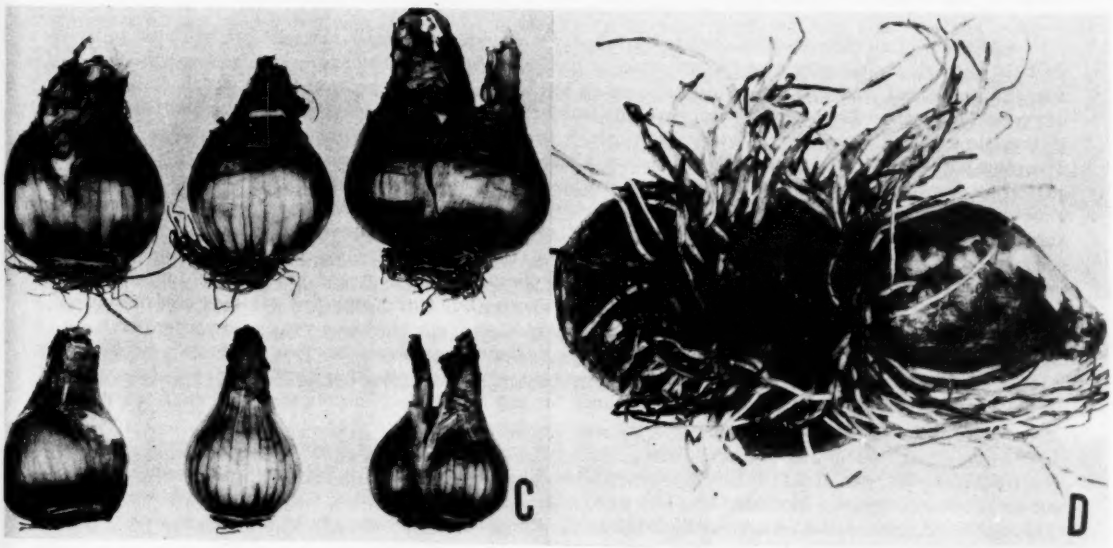
1. Feekes, F. H. Onderzoekingen over schimmelziekten van bolgewassen. Thesis, Univ. of Utrecht. 116 pp. Baarn, Hollandia-Drukkerij 1931. (English Summary R.A.M. 10: 794, 1931.)
2. Gerretsen, F. C., D. J. Hissink, K. Volkersz, and K. Zijlstra. Een onderzoek naar de oorzaken en de bestrijding van het z.g.n. van den wortel gaan van Narcissen en Hyacinthen. Versl. Landbouwkundige Onderzoekingen der Rijkslandbouwproefstations 32: 302-384. 1927 (English Summary R.A.M. 10: 796. 1931.)
3. Hastings, R. J., W. Newton, and G. Steiner. Root decline of narcissi. Plant Dis. Reptr. 16: 112-113. 1932.
4. Van Hell, W. F. Onderzoekingen over ziekten van Lelies. Thesis, Univ. of Utrecht. 99 pp. Baarn, Hollandia-Drukkerij 1931. (English Summary R.A.M. 11: 243. 1932.)

DEPARTMENT OF BOTANY AND PLANT PATHOLOGY, OREGON AGRICULTURAL EXPERIMENT STATION, CORVALLIS; AND OREGON STATE DEPARTMENT OF AGRICULTURE, SALEM.

[1]Published with the approval of the Director of the Oregon Agricultural Experiment Station as Scientific Paper No. 712, Department of Botany and Plant Pathology.

[2]Assistant Nematologist, Oregon Agricultural Experiment Station; Plant Pathologist and Superintendent of Nursery Inspection, Oregon State Department of Agriculture, respectively.

[3]The authors are indebted to Dr. Frank P. McWhorter, Plant Pathologist (Coop. USDA) and H. H. Millsap, Research Assistant (Coop. USDA) Oregon Agricultural Experiment Station, for the photographs used in the article.



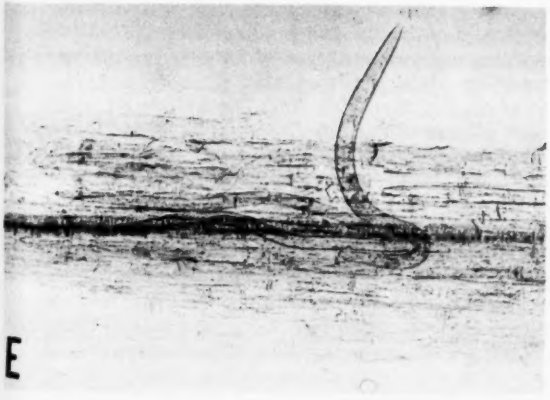




FIGURE 1.

A. A field of King Alfred narcissus showing a large area of diseased plants in the center.
B. The premature yellowing, falling and withering of the foliage as seen in a field of diseased narcissus in early summer.
C. A size comparison of narcissus bulbs produced in non-infested (top row) and infested (bottom row) areas of the field.
D. A diseased "mother bulb" with nearly all of the remaining roots short and stubby due to a girdling or dieback condition.
E. Root-lesion nematodes in a section of narcissus root tissue (about 93 X).

# SURVEY OF VIRUS DISEASES OF CHRYSANTHEMUMS

Philip Brierley[1] and Floyd F. Smith[2]

Before the appearance of the stunt disease about 1945, there was comparatively little interest in virus diseases of chrysanthemums in North America, for losses from these diseases were light. The stunt disease caused great concern among florists and stimulated research. Index procedures developed to detect stunt revealed other virus diseases in chrysanthemums; some of these doubtless had been present earlier but had remained unnoticed or had been passed over as unimportant. The following six virus diseases may now be distinguished.

TOMATO SPOTTED WILT has long been known in English chrysanthemums (1, 12, 13) and has been reported also from California and Washington (14). This disease has not been detected in chrysanthemums at Beltsville, Maryland, although several attempts have been made to isolate the causal virus in tobacco by manual transfer with the aid of 0.5 percent sodium sulfite as recommended by Ainsworth (1). According to K. M. Smith (12, 13) spotted wilt is prevalent in English chrysanthemums, which serve as an important reservoir of the virus. Symptoms are not well defined but are more pronounced in young plants than in older ones. Ring and line patterns, pale areas, mottling, and various necrotic spots have been mentioned by English pathologists as symptoms of this virus in chrysanthemums.

ASTER YELLOWS. Kunkel proved Little Gem chrysanthemums susceptible to aster yellows in 1926 (9), obtaining symptoms consisting of general chlorosis and many secondary shoots. Nelson (10) reported that in 1925 aster yellows in Michigan greenhouses produced green flowers in chrysanthemums. This disease appears in outdoor chrysanthemums each year in the vicinity of Beltsville and has been seen also by the writers in Missouri, New York, Ohio, and Pennsylvania. Symptoms develop also in greenhouses when plants are moved in from outdoor plantings for propagation or for flowering. Green flowers, when produced, are distinctive. Sometimes the lateral shoots on flowering stems are weak, pale, and upright. Thin and weak basal shoots bearing very small leaves often develop in large numbers. One, two, or all three of these symptoms may appear in an individual affected plant. Vein clearing, the familiar first symptom of aster yellows in China asters, is not regularly expressed in chrysanthemums. Aster yellows seldom appears in important percentages of chrysanthemums in nature, but symptoms are striking and damaging in the affected plants. Affected plants of many varieties die within one year after infection, but one hardy variety, Igloo, has survived with well-defined symptoms for five years in a greenhouse. The virus has been transmitted to healthy chrysanthemums by grafting but the weak scions often die without uniting and expression of symptoms is long delayed. The vector, Macrosteles divisus (Uhl.), readily acquires the virus from chrysanthemums.

CHRYSANTHEMUM STUNT is general in the United States and is present in Canada, but it has not been recognized elsewhere. The origin of this disease is still a mystery, but stunt cannot reasonably be regarded as an imported disease. Possibly it is endemic in one of the many hosts, species of the family Compositae, that can carry the virus without recognizable symptoms. A few varieties of chrysanthemums such as Blazing Gold and the Mistletoe group express well-defined leaf symptoms and are thus useful as test plants for detecting the disease in other sorts. Graft indexing on such varieties has made it possible to reselect stunt-free stocks of florists' varieties, and a beginning has been made toward similar reselection of the garden sorts.

A typical symptom of stunt is reduction in size of plant without mottling, distortion, or change in the proportions of organs. The differences in size of normal and stunt plants are most clearly recognized during rapid forcing, and are less evident when plants are grown slowly to normal flowering outdoors, or according to older practice under glass. In some varieties flowers are bleached to lighter shades, stunt plants bloom earlier, or leaves are reduced in size or altered in shape; but in many sorts the difference between stunt and normal plants is ill-defined. Therefore, indexing is the only sure method of detecting all the stunt in a collection of chrysanthemum varieties. Among the useful sorts are the Mistletoe varieties, which after five to eight weeks develop yellow spots up to a quarter-inch in diameter in the leaves and show reduction in leaf size and some

[1]Pathologist, Bureau of Plant Industry, Soils, and Agricultural Engineering, United States Department of Agriculture, Beltsville, Maryland.
[2]Entomologist, Bureau of Entomology and Plant Quarantine, Agricultural Research Center, United States Department of Agriculture, Beltsville, Maryland.

distortion. Spotting is a distinctive symptom except in winter when it is weakly expressed. Blazing Gold expresses a yellowish vein banding in six to eight weeks after being grafted with stunt scions and later shows marked dwarfing. An intensive search for test plants that could be grown from seed revealed only the florists' cineraria (Senecio cruentus DC.) and the plant known to the trade as Matricaria Golden Ball (Chrysanthemum parthenium f. flosculosum (DC.) Beck) as suitable for the purpose. Each of these plants expresses dwarfing and rosetting in two to three months after manual inoculation with stunt virus, but the symptoms are less distinctive than those expressed by Blazing Gold or Mistletoe chrysanthemums. The need for seed-propagated test species diminished with the discovery of chrysanthemum varieties that expressed distinct symptoms after about two months.

All our collections of stunt appear to be uniform, with no evidence of strain variation thus far. The stunt virus is readily transmitted by manual methods and is spread during commercial handling operations, but no insect vector is known (6). No hosts are known outside the family Compositae.

BLANCHE MOSAIC, OR NEWS MOSAIC. Keller (8) was the first to describe the Q virus which he graft transmitted from apparently normal Blanche to Mistletoe. This virus is generally distributed in garden chrysanthemums as well as in florists' varieties. Blanche and several other florists' sorts seem to be 100 percent affected. Typical mosaic symptoms are expressed in Mistletoe and in Good News, which are good test varieties; but many sorts are symptomless when affected. There seems to be variation in virulence among collections of this Q virus from various sources, the symptoms developed in Mistletoe varying from (a) vein clearing and mottling only, through (b) vein clearing, mottling, and leaf-dwarfing, to (c) the most severe type, which includes all these symptoms together with necrosis in the form of leaf and bud blasting and dark-colored blighting of young stems. This virus has been recovered in Mistletoe on graft transfer from an unnamed variety from Denmark intercepted at Hoboken, New Jersey, by Donald P. Limber and from four of eight English varieties -- Delia, Mayford Pink, Perfection, and Venus -- supplied us by an American nursery for trial, as well as from many American sources.

The Q virus is manually transmitted, five of ten plants becoming infected on inoculation from Mistletoe to Mistletoe and 13 of 15 on inoculation from Good News to Good News. The Blanche strain and also the Denmark strain have been passed through cineraria and Matricaria Golden Ball by manual transfers, but neither of these strains caused symptoms to develop in either of these test plants. No insect vector is known for the virus, but tests have not been exhaustive. No hosts are known outside the family Compositae. It is probable that the Blanche mosaic, or News mosaic, caused by the Q virus, is the disease designated as mosaic in chrysanthemum in earlier reports (14), for the Q virus produces more typical mosaic symptoms in suitable chrysanthemum varieties than does any other known virus.

IVORY SEAGULL MOSAIC. A virus that causes no symptoms in the Ivory Seagull source variety but produces yellow vein banding, marked crinkling and dwarfing of leaves, and general dwarfing in the Blazing Gold variety was sent to us by C. J. Olson in July 1950. A somewhat similar virus sample from the variety Manaru also supplied by Olson and a virus from the Matador variety collected at Beltsville are tentatively grouped with the Ivory Seagull virus. On graft inoculation to the Good News variety the three collections induce a dull yellow mottling, leaf dwarfing, and rosetting of shoots distinct from the effects of the Q virus in this variety. There is variation in the intensity of yellowing, crinkling, and dwarfing induced in Blazing Gold by these three collections. The Ivory Seagull virus and the Matador virus are similarly difficult to transmit by manual methods to Blazing Gold, each infecting one of ten plants inoculated. The Ivory Seagull virus is infectious to cineraria and to Matricaria Golden Ball, no symptoms appearing but the virus proving recoverable in chrysanthemum from each of these test plants by manual inoculation. No insect vector is known for the Ivory Seagull virus or for others here grouped with it. No hosts are known outside the family Compositae.

TOMATO ASPERMY. A mosaic disease of chrysanthemum has been reported by various English workers (2, 3, 4, 5, 7, 11, 13). Cucumber virus 1 was first assigned as the cause (3, 11), but the virus has proved to be non-infectious to cucumber (4, 5, 13). K. M. Smith (13) and Blencowe and Caldwell (5) reported that this virus is aphid-transmitted, and Blencowe and Caldwell (5) found that it is inactivated at temperatures above 50°C. The virus causes the disease known as aspermy in tomatoes (5) and is widely distributed in English chrysanthemums (7). Cucumber mosaic virus also occurs in chrysanthemum in England (7) but has not been detected in the United States.

A virus apparently identical with tomato aspermy virus has been recovered in tobacco from two of the eight English chrysanthemums -- Delia, Mayford Pink -- previously mentioned, from the variety from Denmark, and from one American source, the variety Nightingale, supplied us by C. J. Olson in February 1951. The virus isolations from these four sources appear to be alike. Symptoms in tobacco include yellow mottling, extensive white etch or water marking, occasional chlorotic rings and green blisters. The virus is transmissible to zinnia, producing mild yellow mottling, and is recoverable from zinnia in tobacco with unchanged symptom expression. Nicotiana glutinosa is susceptible, but all attempts to infect cucumber and Pinto beans have failed. Systemic infection of zinnias with this virus fails to protect them against Price's tester strain of cucumber virus 1, in contrast with cucumber virus strains from dahlia, gladiolus, and Impatiens, which consistently protect in such tests. In a single trial this virus was inactivated at temperatures of 50°C and above, but it infected five of five plants when unheated. In two trials the virus was transmitted from chrysanthemum to tobacco in the non-persistent manner by Myzus persicae (Sulz.), infecting one of ten and three of ten plants exposed. There is thus good agreement between our results thus far and those reported by Blencowe and Caldwell (4, 5) and by K. M. Smith (13).

The four chrysanthemums from which we have recovered this virus show weak symptoms or none. Olson detected a slight leaf abnormality in Blazing Gold grafted to the Nightingale source. Inoculations from Nightingale to Mistletoe and to Good News by manual methods and by grafting resulted in no symptom expression in vegetative growth. K. M. Smith (13) reported that English chrysanthemum varieties are stunted, the leaves are mottled and the flowers are malformed when the plants are affected. Selman (11) and Bewley and Richards (3) mentioned breaking of the flower color in some varieties. The last named workers also described distinctive flower malformations and considered this disease important in chrysanthemums. Blencowe and Caldwell (5) stated that symptoms in chrysanthemum are sufficiently obvious to be recognized, but difficult to describe. There is apparently great variation in symptom expression in the various chrysanthemum varieties. Those seen affected thus far in this country are not noticeably injured by this disease.

Literature Cited

1. Ainsworth, G. C. Detection of spotted wilt virus in chrysanthemums. Nature 137: 868. 1936.
2. _____. Virus diseases. (A) General. In Exp. and Res. Stat. Cheshunt 24th Ann. Rept. p. 60. 1938.
3. Bewley, W. F. and Richards, A. A. Mosaic disease of the chrysanthemum. Gard. Chron. (London) 129 (3341): 20. 1951.
4. Blencowe, J. W. and Caldwell, J. A new virus disease of tomatoes. Nature (London) 158: 96. 1946.
5. _____ and _____. Aspermy - a new virus disease of the tomato. Ann. Appl. Biol. 36: 320-326. 1949.
6. Brierley, P. and Smith, F. F. Chrysanthemum stunt. Flor. Rev. 107 (2778): 27-30. 1951. Also in Southern Flor. and Nurs. 63 (49): 9-11, 96-99. 1951.
7. Caldwell, J. Further observations on chrysanthemum virus disease. Gard. Chron. (London) 129 (3356): 141. 1951.
8. Keller, J. R. Chrysanthemum stunt. New information from Cornell University on virus diseases. Flor. Rev. 107 (2762): 37-38. 1950.
9. Kunkel, L. O. Studies on aster yellows. Amer. Jour. Bot. 13: 646-705. 1926.
10. Nelson, R. Chrysanthemum yellows; a new disease in the greenhouse. Michigan Agr. Expt. Stat. Quart. Bull. 7: 157-160. 1925.
11. Selman, I. W. A virus disease of chrysanthemum. In Exp. and Res. Stat. Cheshunt 25th Ann. Rept. p. 36-37. 1939.
12. Smith, K. M. Some diseases of ornamental plants caused by the virus of tomato spotted wilt. Jour. Roy. Hort. Soc. 60: 304-310. 1935.
13. _____. Viruses and virus diseases. Jour. Roy. Hort. Soc. 74: 482-491, 521-528. 1949.
14. Weiss, Freeman. Check list revision (chrysanthemum). Plant Dis. Reptr. 32: 147-148. 1948.

BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING AND BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE.

# VIRUS DISEASES OF STRAWBERRIES IN THE UNITED STATES, WITH SPECIAL REFERENCE TO DISTRIBUTION, INDEXING, AND INSECT VECTORS IN THE EAST

J. B. Demaree and C. P. Marcus[1]

Probably the earliest observation of a pathological disorder caused by a virus in strawberry plants was made by W. H. Hyde, Watsonville, California, but the cause was not recognized at the time. In 1915 he sent affected plants to the University of California at Berkeley. A short account of the disease by Horne (8) in 1922 included a meager description and a list of climatic and soil conditions supposedly contributing to its cause. Plakidas (10), in a comprehensive report on this disease in 1927, gave adequate proof that it was caused by a virus. He assigned the name xanthosis, or yellows, stated that it was a limiting factor in strawberry production in California, and mentioned that it occurred also in Oregon and Washington.

Three other strawberry virus diseases, witches'-broom, crinkle, and stunt, have been reported in Oregon. Witches'-broom and stunt are now rare and the status of crinkle is obscure. In 1933 Zeller (15) questioned the validity of Plakidas' (10) report of yellows in Oregon, but in 1941 (16) he stated "large infection areas [of yellows] are now to be found."

## STRAWBERRY VIRUS DISEASES IN EASTERN UNITED STATES

It is not known when virus diseases first appeared in strawberry fields in eastern United States. In 1931 Mook[2] was among the first to recognize what he considered a virus disease in strawberry east of the Rocky Mountains. He saw the disease known locally under such names as "multiplier plant," "bushy plant," "spindly plant," and "witches'-broom" in New York, Minnesota, Wisconsin, and northern Illinois. Apparently this disease was much more abundant then than at present, for Mook estimated that some fields were 30 percent to 75 percent infected. Infected plants have a bushy appearance due to the production of many branch crowns. The petioles are relatively long and spindly and the leaf blades small. The stolon internodes are short and the runner plants become established near the mother plant. On account of the conspicuous symptoms, the disease is easily recognized by growers and infected plants are readily rogued. The writers have transmitted the disease through stolon grafts, thus confirming Mook's belief as to its virus nature.

Another virus disease of minor importance in the East was called "leaf roll" by Berkeley and Plakidas (2), who reported it in Ontario and New York in 1942. Later it was seen by the senior writer in Maryland and New Jersey and infected plants were received from New York and Vermont. Symptoms of this disease vary with the variety, but rolling or twisting of leaflets is a character common in all varieties observed and a greenish-yellow mottling of leaves is seen in some plants. Rarely are there more than a few infected clones in a field. Infected plants are fairly vigorous and produce the normal number of stolons. Multiplier plant is locally important in Wisconsin but leaf roll is of little importance anywhere.

Leaf variegation, or June yellows, in Blakemore, Premier (Howard 17)[3], and a few other varieties, mistaken by some people for a virus manifestation, is considered a genetic trouble. Affected foliage shows various symptoms -- from very slight mosaic of green and yellow to extensive streaks and sections of yellow and finally total chlorosis, resulting in gradual dying of the plant.

The most prevalent and destructive virus diseases in strawberries east of the Rocky Mountains are now thought to be of the yellows type. These virus diseases may have been present, even though unrecognized, in eastern United States for several years, but a Farmers' Bulletin by Stevens (11), issued in 1925 and revised in 1933, made no mention of strawberry virus diseases in the East. In 1941 Demaree (3) reported that strawberry virus diseases were unknown except west of the Rocky Mountains. By implication, he revised this statement five years later, when he reported that a virus disease does occur in eastern United States, but that its distribution and prevalence are not fully determined (4). He did not identify the disease but said that it is of the yellows type.

---

[1]The writers are indebted to Agricultural Experiment Station and State plant inspection officials, county agents, nurserymen, and farmers for their generous assistance in collecting and submitting strawberry plants for indexing; to several Agricultural Experiment Station officials and members of the Division of Truck Crops and Garden Insect Investigations, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, for collecting strawberry aphids; to Miss Louise M. Russell, Division of Insect Identification, Bureau of Entomology and Plant Quarantine, for identifying numerous collections of aphids; and to the University of Maryland for assistance in the indexing by J. E. Howes.

[2]Mook, P. W. Strawberry dwarf survey 1931. Unpublished report.

[3]The variety Premier is also known as Howard and Howard 17, especially in the New England States.

## INDEXING EASTERN STRAWBERRY VARIETIES FOR VIRUS DISEASES

About 1938 a limited number of plants of the variety Catskill in eastern fields were recognized as abnormal. The abnormal plants were moderately dwarfed; new leaves, especially in the autumn, were slightly yellow and distorted; and runner production was reduced. The number of abnormal plants increased during the next few years until it was difficult to find normal plants of Catskill. About the same time the variety Dorsett began to show decline, but the symptoms were different from those in Catskill. Deviation from the normal was only moderate, leaves were small and cupped upward, petioles were slightly shortened, and the number of runner plants was reduced. Later other eastern varieties were suspected of being affected and the supposition was confirmed by indexing. Now, it is known that a majority of the numerous varieties grown in eastern United States are infected with viruses, even though many show no visible symptoms.

The presence of virus diseases in eastern varieties which show no symptoms can be demonstrated only by indexing to some more sensitive species or variety. However, if virus-free plants of highly tolerant varieties were available for comparison under field conditions with virus-infected plants of the same varieties marked differences might show.

The virus problem in eastern varieties would be much less difficult and confusing if the virus diseases most prevalent had some definite identifying characters, such as leaf mottling, spotting, asymmetry, and distortion or some abnormal flower or fruit characters whereby quick and definite field determinations could be made. Such definite identifying characters, however, have not been observed except in a few varieties.

### MATERIALS INDEXED AND METHOD OF INDEXING:

Most plants to be tested for virus infection were obtained from experiment station workers, plant inspection officials, county agents, nurserymen, and farmers. Since a search was being made for virus-free plants, those cooperating were requested to select vigorous plants from well-bedded sections of fields or to take them from fields having a reputation for high yields or from properties where a stock of plants had been maintained for several years without recent introductions from outside sources.

Plants received from the cooperators were immersed in nicotine sulfate solution, at a concentration of 1 to 400, to kill all aphids that might be present. In addition, the greenhouses were fumigated with parathion in an aerosol every two weeks during the indexing season to exclude insect vectors. Seven of the most vigorous plants of each lot were set in 6-inch pots and placed in a sanded greenhouse bench. When stolons began to form, the weakest four of the original seven plants were discarded. During this period a stock of indicator plants was grown in pots for grafting to the plants to be tested. When a stolon on a plant to be tested attained a length of 8 to 12 inches, it was inarched to a stolon of an indicator plant of about the same length and age. So that the two stolons would lie parallel, the incision was made toward the tip of the stolon of one plant and in the opposite direction on the other. The two tongues were fitted together and a short length of 1/4-inch tape was wrapped around the two stolons, one above and one below, to hold the graft in place; then a longer strip of tape was wrapped around the entire graft. Pairs of grafted plants were lined up along the two sides of the sanded benches, with the grafted stolons extending outward. Each stolon soon formed runner plants that rooted in the damp sand on the bench bottom. The incisions united in about a week, but the grafted stolons were allowed to remain intact for four to six weeks to permit the establishment of runner plants on each. Then the grafted stolons were severed and their runner plants were potted, given a serial number, and set aside for future observations or use. The original variety plant was discarded if it was found infected as there was always a possibility of its being infested with bud nematodes or cyclamen mites or infected with the red stele root disease, but the old indicator plants with their runners were kept. If the indicator plants appeared normal when the stolons were severed, the variety plants tested were ultimately regrafted to confirm the first test. Usually indicator runner plants, rather than the original indicator plant, were used to determine the index reaction as the virus did not always show in the parent indicator plant, even though virus symptoms showed in the runners. Occasionally the reverse action resulted. The runners of virus-free plants were used for mass propagation for later distribution to commercial plant growers and others interested.

Normally only two runner plants of a virus-free variety were available for propagation from a single test; hence, increase was slow in the beginning. Propagation in summer was considerably hastened when the two plants were immediately set in greenhouse benches in fertile soil under partial shade. Under such conditions early-season-tested plants usually formed 50 to 75 runner plants each the first year. Since 1950 stock of a clone of Fragaria vesca L. obtained from R. V. Harris, East Malling, England, has been exclusively used as the indicator at Beltsville, Maryland (Fig. 1).

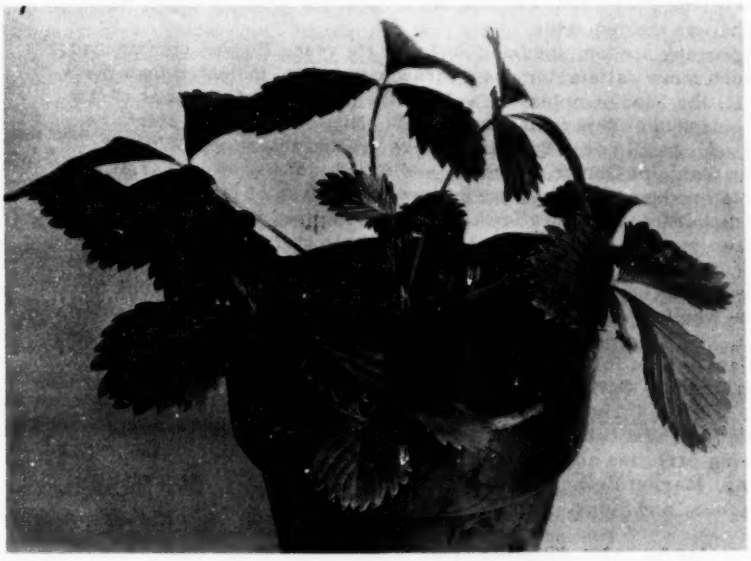


FIGURE 1. Normal plant of the East Malling clone of Fragaria vesca.

Plants of this clone grow rapidly and form stolons freely in the greenhouse. This clone is not especially susceptible to nonvirus diseases. Perhaps its most important merit is that virus types and combinations of types can be distinguished on it. The plants are sufficiently sensitive to most virus types to give definite and clear-cut symptoms within a few days after infection, but not so sensitive as to be killed by the virus prior to showing characteristic foliage symptoms. Only the most virulent types of viruses are lethal to them; therefore, infected plants serve as records of symptoms as long as needed. The writers have maintained infected plants for two years. Indicator plants so sensitive that they may die shortly after infection in the absence of other symptoms cannot be considered satisfactory index plants in strawberry virus studies.

The East Malling clone of Fragaria vesca, however, possesses certain undesirable characteristics. It is not a robust grower and consequently its stolons are thin. No difficulty has been experienced, however, in obtaining 95 percent unions in stolon grafts. The most bothersome weakness of plants of this clone is a transitory spotting of the leaves, reminiscent of virus symptoms under certain cultural conditions and of mealy bug injury. The spots, which are more or less circular and yellowish-green, show only on plants lacking in vigor. When spotted plants are fertilized or repotted in better soil the new leaves formed are free of spots. The spotting is thought to be of a genetic origin rather than due to a mild form of virus. This theory was supported by the results observed on growing seedlings from seeds obtained by selfing. After the seedlings had grown several months in small pots and had become root-bound, their leaves developed the same spotting as is often seen on plants of the original clone. Thus, the trouble is genetic or if induced by a virus is almost 100 percent seed transmitted.

VIRUS-FREE VARIETIES OBTAINED BY INDEXING:

Indexing of strawberry plants in the East to obtain virus-free plants was initiated in 1946; preliminary work had indicated that virus-free plants here were almost nonexistent. Since that time many field samples have been tested. In 1946, 77 samples of plants selected for their vigor and consisting of 27 varieties from 11 eastern States were indexed on the variety Marshall. Although the Marshall is sufficiently satisfactory as an index plant to screen out the most virulent types of viruses, it is not dependable for indicating mild types. Nevertheless, symptoms in the Marshall were clear enough to determine that 69 of the 77 samples were infected and they were discarded. Plants of 8 varieties, Blakemore, Culver, Dorsett, Fairfax, Klondike, Klonmore, Tennessee Beauty, and Tennessee Shipper, were retained for additional testing. The Blakemore plants, although considered virus-free, developed the genetic trouble termed "leaf variegation", or "June yellows", and were discarded in 1949. No plants were indexed in 1947. The following

year (1948) 60 lots of plants of 30 varieties from 10 States were indexed. Only a few of these were carried over for further testing. In 1949, 140 lots of 32 varieties from 16 States were tested, with the variety Marshall as the indicator.

Near the end of the 1949 growing season, indexing on Fragaria vesca (5) was commenced. The F. vesca clone proved much more satisfactory as a strawberry virus indicator than the Marshall variety; therefore, all the 1949 samples, as well as the most promising ones of the 1946 and 1948 series, were reindexed on this indicator in 1950. Numerous lots of plants received in 1950 were also indexed. In all, over 900 plants were grafted that year. With the use of the better indicator, the plants of Culver, Dorsett, and Fairfax of the seven varieties of the 1946 indexing series retained because they were believed to be free of virus, were found to be infected and were discarded; the other four varieties continued to test virus-free. From two plants of each of these varieties obtained in 1946, approximately 13,000 plants of Klondike, 13,000 of Klonmore, 27,000 of Tennessee Beauty, and 23,000 of Tennessee Shipper have been grown. They were placed with cooperating nurseries in the spring of 1951 for mass propagation to determine whether they could be kept virus-free under field conditions and for general distribution.

Since 1946, virus-free plants of the following other varieties have been found as the result of indexing: Armore, Blakemore, Corsican, Fairfax, Massey, Premier, Sparkle, Tennessean, and Vermilion. Plants of these varieties should be available for distribution through commercial plant growers after the next two or three years.

A few plants of the following varieties are tentatively considered virus-free: Aroma, Beaver, Big Joe, Dunlap, Gem, Konvoy, Marion Bell, Mastodon, Midland, Missionary, Progressive, Robinson, Superfection, Suwannee, and Sioux.

## SURVEY FOR IMPORTANT STRAWBERRY VIRUS DISEASES

A field survey for determination of the distribution and prevalence of strawberry virus diseases has not been made. In fact, such a survey would probably be of little value in eastern United States since distinctive diagnostic characters that can be used as a basis for detecting infected field-grown plants are not always present. However, some information has been obtained about prevalence and distribution of virus diseases east of the Mississippi River and in Missouri and Arkansas in connection with the project primarily designed to locate virus-free plants of the most valuable eastern varieties for propagation to replace the present stocks of infected plants.

If field sampling of plants and subsequent indexing in a greenhouse under controlled conditions constitute a satisfactory criterion for determining the distribution and prevalence of strawberry virus diseases in eastern United States, then we may assume that a fairly accurate survey, especially in some States and for a few varieties, has been made. Many samples were obtained from strawberry nurseries and those samples alone furnished information as to what may be expected in gardens and commercial fields in areas where these nurseries sell plants.

Table 1. Frequency of virus-diseased strawberry plants in several eastern and central States as determined by indexing field-grown plants, 1950.

| State | Plants indexed | Plants virus-free | State | Plants indexed | Plants virus-free |
|---|---|---|---|---|---|
| | Number | Number | | Number | Number |
| Arkansas | 12 | 4 | New Jersey | 71 | 4 |
| Connecticut | 19 | 0 | New York | 30 | 0 |
| Kentucky | 11 | 7 | North Carolina | 30 | 11 |
| Maryland | 133 | 2 | Ohio | 10 | 0 |
| Massachusetts | 45 | 0 | Pennsylvania | 43 | 3 |
| Michigan | 42 | 0 | Tennessee | 81 | 33 |
| Mississippi | 8 | 2 | Virginia | 18 | 6 |
| Missouri | 26 | 0 | West Virginia | 20 | 7 |

Table 1 suggests that as a rule strawberry plants are less likely to have virus diseases in southern States than in northern ones. Samples from southern States had a fairly high percentage of what were considered virus-free plants. Although the number of samples received from some southern States was small, a few good plants were obtained from each. The picture is

much different in the northern half of the eastern United States. Many more plants were tested than from the South, but only an occasional virus-free sample has been found. In some northern States such as Connecticut, Massachusetts, Michigan, New York, and Ohio, and in Missouri, no virus-free samples were found. A few virus-free plants were obtained from Maryland, New Jersey, and Pennsylvania.

The frequency of virus-free plants from the several States, as indicated in Table 1, does not necessarily reflect the relative freedom from virus-infected plants in all fields in the several States as the plants selected for testing were not collected systematically or at random. Although, as stated previously, especially vigorous plants were requested, the data presented are believed to have some significance relative to the over-all distribution of eastern strawberry virus diseases. The values in the column headed "Plants indexed" represent plants or samples collected from different locations. For example, the plants indexed from Tennessee represent 10 varieties from at least 25 fields or parts of fields and those from New Jersey 7 varieties from 26 fields.

Table 2. Frequency of viruses in some strawberry varieties in eastern United States, as determined by indexing field-grown plants.

| Variety | Plants indexed | Plants virus-free | Variety | Plants indexed | Plants virus-free |
|---|---|---|---|---|---|
| | Number | Number | | Number | Number |
| Aberdeen | 13 | 0 | Midland | 17 | 0 |
| Aroma | 15 | 0 | Missionary | 14 | 0 |
| Blakemore | 52 | 15 | Premier | 95 | 7 |
| Catskill | 80 | 5 | Redstar | 10 | 0 |
| Dorsett | 27 | 0 | Robinson | 28 | 0 |
| Dunlap | 12 | 0 | Suwannee | 7 | 0 |
| Fairfax | 22 | 5 | Sparkle | 27 | 2 |
| Fairland | 22 | 0 | Temple | 15 | 0 |
| Klondike | 19 | 6 | Tennessee Beauty | 13 | 12 |
| Klonmore | 6 | 3 | Tennessee Shipper | 14 | 5 |
| Massey | 7 | 6 | | | |

Table 2 also indicates that virus-free plants are more often found in southern varieties than in others. The varieties Aroma and Missionary, two old southern varieties, are exceptions, as plants of these free of virus are rarely found. We have yet to find virus-free plants of such northern varieties as Aberdeen, Bellmar, Chesapeake, Lupton, Redstar, Dorsett, and Temple. In northern varieties such as Catskill, Fairfax, Premier, and Sparkle some virus-free plants have been found, but the numbers are small.

In connection with the general survey made as to the distribution and prevalence of virus diseases in strawberries in eastern United States, some new varieties, selections, and seedlings in breeders' plots were indexed in 1950. The results (Table 3) were surprising as they showed that most new varieties and some selections and seedlings tested were infected with viruses. Since viruses are not known to be transmitted through strawberry seeds, it must, therefore, be assumed that the breeders' plots had at some time, or perhaps continually, been infested with viruliferous insect vectors. Evidence of such association, both direct and indirect, has been observed by the writers. Vectors have been seen in most strawberry breeding trial plots examined. It has further been observed that plants of seedlings and selections during the early years of testing were vigorous; they had large leaves and long petioles and produced an adequate number of runner plants. Some of those clones retained sufficient vigor to warrant additional testing while others declined rapidly each year until they were unsuitable for further use. That decline in vigor, at least in part, undoubtedly was caused by the breeding stock becoming infected with virus. Clones that retained their vigor were tolerant sorts and those that declined rapidly were more sensitive to virus infection.

## SYMPTOM EXPRESSIONS IN INDICATOR PLANTS AS A METHOD OF SEPARATING VIRUS TYPES

Two distinct and easily distinguishable types of virus symptoms have been transmitted from eastern-grown field plants to plants of the East Malling clone of Fragaria vesca by making use of the stolon-graft method and by aphid vectors. These symptom types are designated as virus types

Table 3. Result of indexing strawberry selections, seedlings, and comparatively new varieties on Fragaria vesca, 1950.

| Variety, seedling, or selection | Origin | Year introduced | Indexed as | Variety, seedling, or selection | Origin | Indexed as |
|---|---|---|---|---|---|---|
| Variety | | | | Selection | | |
| Armore | Mo. | 1950 | Virus-free | Md. 1952 | USDA-Md. | Virus-infected |
| Arrowhead | Minn. | 1946 | Virus-infected | Md. 1972 | " | " |
| Campbell | Calif. | 1949 | " | NC. 1077 | USDA-NC. | Virus-free |
| Cupertino | " | 1949 | " | NC. 1233 | " | " |
| Essex | N. Y. | 1950 | " | NC. 1271 | " | " |
| Fairland | USDA-Md. | 1947 | " | NC. 1320 | " | " |
| Great Bay | N. H. | 1949 | " | NC. 1369 | " | " |
| Northwest | Wash. | 1950 | " | NC. 1225 | " | Virus-infected |
| Redcrop | N. J. | 1949 | " | NC. 1243 | " | " |
| Valentine | Ontario, Canada | 1948 | " | NC. 1247 | " | " |
| Vermilion | Ill. | 1950 | Virus-free | | | |
| Tennessean | Tenn. | 1950 | " | | | |
| Seedling[a] | | | | | | |
| Klonmore x Midland | Md. | -- | Virus-infected | V. 41021 | Ontario, Canada | " |
| Klondike x Rockhill | " | -- | " | V. 41022 | " | " |
| Midland x Klonmore | " | -- | Virus-free | Wis. 537 | Wisc. | " |
| Fairmore x Klondike | " | -- | " | Tenn. 654 | Tenn. | Virus-free |
| T.S. x N.C. 1053 | " | -- | " | Tenn. 866 | " | " |
| Massey x Klondike | " | -- | " | Tenn. 879 | " | " |
| | | | | Tenn. 903 | " | " |

[a]A plant of each of the following crosses were indexed.

1 and 2, which are in no manner comparable to numbered designations of other investigators. No attempts were made to determine whether the symptom types are caused by a single virus entity or by a combination of two or more.

The virus or viruses that may cause type 1 symptoms are believed to be identical with, or at least similar to, the ones causing yellows and crinkle in our Western States and yellow edge and crinkle in the British Isles. Type 2 disease seems to be confined to eastern United States, as it has not been reported elsewhere. Because symptoms of both types are masked in most eastern varieties, it is considered inappropriate to use common names at present to designate strawberry virus diseases when one cannot determine what virus type may be present in a particular plant or field until the virus is transmitted to the indicator plant. The writers, therefore, prefer at present to use the general term "virus disease" when referring to these diseases in the East.

TYPE 1 VIRUS SYMPTOMS :

Type 1 virus seems to be widely distributed and symptom expression is variable. In the East it was most frequently transmitted from plants obtained from the mid-Atlantic States and occasionally from other Eastern States. It was also obtained from plants grown in Oregon and Wyoming, as well as from plants from Turkey. The most accentuated symptoms of this virus type, as expressed on Fragaria vesca, are small, dark green or yellowish leaves, wrinkled or puckered, and streaked or spotted with yellow. The leaflets often vary in size and shape. It is not unusual for one or two leaflets to be extremely small or absent. The entire plant is moderately dwarfed because of the small leaves and short petioles. Only a few weak thin stolons form after the indicator is infected (Fig. 2). When the disease is less severe, symptoms consist of dwarfing and some spotting only; or the leaves are normal in size, but the leaflet tips are turned downward and show some spotting.

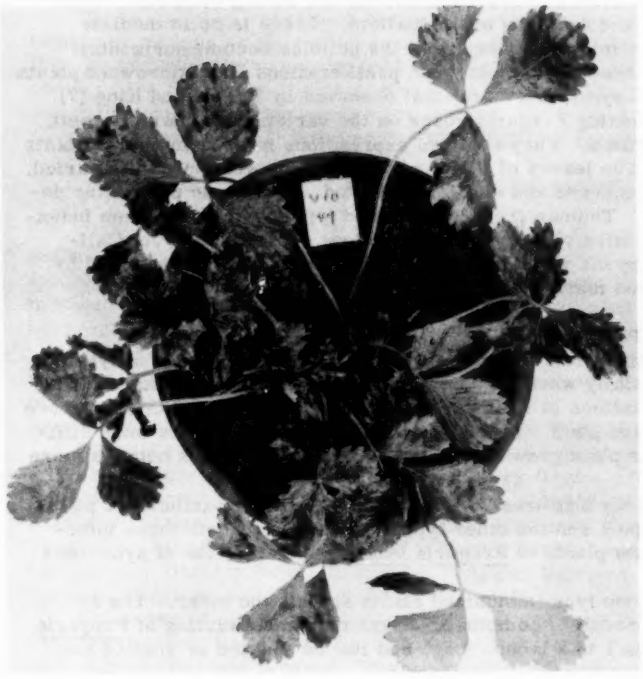


FIGURE 2. Plant of East Malling clone of Fragaria vesca, showing type 1 virus symptoms. Leaflets are distorted, puckered, mottled and spotted. Bud proliferations are absent. Photographed about 1 year after infection.

FIGURE 3. (right) Plant of East Malling clone of Fragaria vesca, showing type 2 virus symptoms. Leaflets are small, smooth, green or slightly mottled. The many bud proliferations form a multicrowned plant. Photographed about 1 year after infection.

TYPE 2 VIRUS SYMPTOMS:

Type 2 disease is widely distributed in the East, being found in all States from which samples of field plants were obtained. Symptoms as expressed on Fragaria vesca were quite uniform regardless of variety or location from which the infector plants came. Leaves of F. vesca when infected with type 2 virus are small and yellowish-green. The leaflets are smooth, normal in shape, and uniform in size. Puckering, spotting, and streaking are not symptoms of this virus type.

Young runner plants of the indicator when infected are spreading, the older leaves being horizontal and close to the soil. Petioles are shorter than normal. Leaflets and petioles of the younger leaves turn downward so that the under side of the leaflets show from above. Petiole and leaflet epinasty is a prominent symptom for several weeks. Later the petioles assume an upright position and bud proliferations gradually develop from the stem, resulting in multicrowned plants. Plants several months old sometimes have 100 or more small, spindly shoots crowded on the original stem (Fig. 3).

When the virus is transmitted to a mature indicator plant the early symptoms are somewhat different. The leaves that form after infection are chlorotic and exhibit strong epinastic tendencies, shown by recurving of the petioles and drooping of the leaflets. There is no immediate effect on the older leaves formed prior to infection except that the petioles become horizontal. These outer leaves die later. The final effect of the many bud proliferations is multicrowned plants.

It is believed that the writers' type 2 symptoms were first observed by Harris and King (7) and reported in 1942, as the result of indexing Fragaria vesca on the varieties Fairfax, Dorsett, and Premier imported from the United States. They obtained expressions in their indicator plants dissimilar to any previously observed. The leaves of their indicator plants were curled, dwarfed, and greenish-yellow, but they were not puckered and chlorotic-spotted. The whole plant later developed a "matted tussocky appearance." Thomas (12) also obtained type 2 symptoms when indexing plants obtained from eastern United States on plants of a wild clone of F. vesca from California. He named the disease exhibited by his indicator "droop," a term evidently suggested by the epinasty of the leaves on newly infected mature plants.

SYMPTOMS CAUSED BY VIRUS-TYPE MIXTURES:

Clear evidences of combinations or mixtures of virus types were found. Mixtures of types 1 and 2 were frequently encountered, especially when the infector plants came from the mid-Atlantic States. There were considerable variations in the symptoms on the indicator plants when there was a combination of entities in the infector plant. In the early stages such symptoms were difficult to classify. As the affected indicator plant grew older, the combined symptoms became more accentuated.

The assumption of the presence of virus mixtures was verified by grafting together two plants of known virus content, one containing type 1 and the other type 2. Later when both these infectors were grafted independently to separate plants of Fragaria vesca, a combination of symptoms appeared in each.

There is no evidence to suggest that one type immunized plants against the other. The reverse, in fact, was indicated. The final result of combinations was extreme dwarfing of Fragaria vesca, many adventitious crowns, petioles 1 to 2 inches long, and leaves mottled or spotted and extremely small (Fig. 4).

FIGURE 4. Plant of East Malling clone of Fragaria vesca, showing combination of type 1 and type 2 virus symptoms. Leaflets are very small, smooth, and mottled. Petioles are mostly upright, very short and thin. There are several spindly crowns on original stem. Photographed about 1 year after infection.

## MISCELLANEOUS EXPERIMENTS WITH STRAWBERRY VIRUSES

Since it was learned that Potentilla simplex Michx. (P. canadensis L. of most authors) appeared to be a host for one of the aphid vectors of strawberry viruses, plants of this species were brought into the greenhouse and grafted to Fragaria vesca. The plants used proved to be virus-free. Then some of the tested Potentilla plants were grafted to strawberry plants known to be infected with type 1 virus and others were grafted to type-2-infected plants. No signs indicated transmission of viruses into the Potentilla plants as the result of the grafting except possibly some slight dwarfing after an incubation period of six weeks. When both series of Potentilla plants were later grafted to virus-free F. vesca plants, the latter developed definite virus symptoms. One series gave type 1 symptoms and the other type 2 symptoms in the indicator plants, suggesting that P. canadensis may carry either virus type and yet not exhibit any definite symptoms.

One dodder species, Cuscuta campestris Yuncker, was established on seven Fragaria vesca plants showing typical symptoms of type 1 virus. The dodder stems growing from each plant were then trained to each of seven virus-free F. vesca plants. It was thought that the dodder became

established on each of the clean plants. However, type 1 symptoms were transmitted to but one of the seven plants.

Three attempts were made to transmit virus mechanically to cucumber and one attempt to tomato by rubbing slightly diluted juice on cotyledons, as described by Moore, Boyle, and Keitt (9). Twice the juice was expressed from young leaves and once from stems of infected strawberry plants. The three lots of plants used were of different ages when inoculated. The first lot was treated ten days after the seeds were planted, the second lot seven days, and the third lot five days from planting. All three series gave negative results.

## STRAWBERRY VIRUS INSECT VECTORS

Plakidas (10) proved that the strawberry aphid Capitophorus fragaefolii (Ckll.) readily infected strawberry plants with the virus causing xanthosis, or yellows. Zeller (14) transmitted witches'-broom virus, and Vaughan (13) used the same insect species successfully for transmitting the virus causing crinkle. This aphid is reported to be widely distributed in most strawberry-growing sections in the three Pacific Coast States.

Because of its apparent scarcity east of the Mississippi River, Capitophorus fragaefolii is believed to be of minor importance in transmitting strawberry virus in the East. Among numerous collections of aphids from strawberries in that region during the past four years, it was found only in those from Geneva, New York, and Madison and Sturgeon Bay, Wisconsin.

Capitophorus minor (Forbes) and an unnamed species of Capitophorus resembling C. fragaefolii are frequently found in eastern strawberry fields.

Capitophorus minor has been collected on strawberry plants near Adairville and Oakville, Kentucky; Hammond, Louisiana; Beltsville, Maryland; Benton Harbor, Michigan; Long Creek, Tabor City, Teacheys, Raleigh, and Willard, North Carolina; Geneva, New York; Ashburn, Clarksville, Hickory Point, Nashville, Orlinda, Portland, Sango, and Springfield, Tennessee; Norfolk, Virginia; and Sturgeon Bay, Wisconsin.

The unnamed species of Capitophorus was collected on strawberry plants near Selbyville, Delaware; Allen, Beltsville, College Park, Pittsville, Salisbury, and Willards, Maryland; Andover, Barnstable, and Roxford, Massachusetts; Raleigh and Teacheys, North Carolina; Wooster, Ohio; Crossville, Tennessee; and Arlington, Virginia. This species was collected also at Morgan Hill, Santa Ana, Torrance, and Watsonville, California; and at Mt. Vernon, Washington.

Capitophorus minor and the unnamed species of Capitophorus were successfully used, it is believed for the first time, by the writers for transmitting strawberry viruses. They readily transmitted both eastern virus types from infected field plants to Fragaria vesca under controlled conditions and it is suspected these two species of insects play an important part in spreading strawberry virus diseases, especially in the East.

Frazier (6) tested experimentally eight aphid species other than those in the genus Capitophorus for their ability to transmit strawberry viruses. He used Amphorophora rubi (Kalt.), Myzaphis rosarum (Walk.), Macrosiphum pelargonii (Kalt.), Myzus ornatus Laing, Myzus porosus Sanderson, Aphis forbesi Weed, Macrosiphum solanifolii (Ashm.), and Myzus solani (Kalt.). All except the last three proved to be vectors, but they were less efficient transmitters than Capitophorus fragaefolli, commonly known in the West as the strawberry aphid. The practical importance of these findings cannot be properly evaluated until more is known about the frequency of feeding of the five transmitting species on strawberries. Aphis forbesi, the strawberry root louse, is abundant almost everywhere strawberries grow and it is important to know that it does not transmit viruses. It is also important to know the status of Myzus porosus and Macrosiphum solanifolii as they also are frequent habitants of strawberry plants.

## FIELD OBSERVATIONS ON HABITS AND PREVALENCE OF EASTERN STRAWBERRY APHIDS

Very little is known about the habits and life history of the unnamed species of Capitophorus. The writers have made some field observations that may be helpful to others in identifying this insect and as a basis for control measures. The wingless females, the form most often present, are clear white in the early instar stages and become greenish-white as they mature. All instars have rather conspicuous capitate setae arranged in rows on the dorsal surface. The aphids prefer to feed on the underside of young leaves and on young petioles during the spring, summer, and fall, but during the winter most of them are found on the underside of old leaves lying on the soil. The population decreases during the summer and increases during the fall and spring. There is also some increase of aphids during the warm periods in winter. The insect varies in abundance from year to year. On the Eastern Shore of Maryland, there has been a moderate infestation for the

past 10 years. There were heavy infestations during the fall, winter, and spring of 1946-47 in the vicinities of Beltsville and Salisbury, Maryland, and again in 1949-50 at Beltsville. Some years the population was extremely low or seemingly absent, even in fields where it was abundant the previous year.

The winged forms begin to appear in Maryland in late April and may be found through May and June. None have been observed in summer, but a few have been seen in the fall. During the mild winter of 1949-50 winged aphids were collected at Beltsville in January.

Capitophorus minor is similar in gross appearance to the unnamed species except that the capitate hairs on the wingless females are less abundant and are clearly seen only on the head and the two last segments of the abdomen. Mature apterous females are yellow.

This species lays eggs during late fall in the vicinity of Beltsville, Maryland. In the autumn of 1949 a moderate infestation of this aphid species was observed in one strawberry field, when in November numerous eggs, first white but later changing to black, were observed on the under surface of leaves. The aphids disappeared in December. As it was suspected that the eggs were those of Capitophorus minor, some were incubated in a warm room the following spring. Aphids hatched from the eggs and were identified by Miss Louise M. Russell as C. minor.

Baerg (1), reporting upon Capitophorus brevipilosus, a species resembling C. minor, in Arkansas, said that the wingless form develops in great numbers in early spring but that the population decreased in summer and increased again in the autumn and during warm periods in winter in Arkansas. It was thought that winged forms might appear at any time but they were observed to be most abundant in the fall of the year; neither sexual forms nor eggs were found.

## SUMMARY

Investigations during the past few years have proved that most plants of cultivated strawberries in eastern United States are infected with one or more viruses. Definite identifying characters such as leaf mottling, spotting, asymmetry, distortion, or abnormal flower or fruit characters are not commonly seen in plants of most eastern varieties. Varieties most sensitive to virus infection show principally dwarfing -- due to short petioles and small leaves -- and reduction in number of runner plants, resulting in thin stands of plants and consequently lower berry yields.

The presence of virus diseases in varieties which show no definite symptoms can be demonstrated by indexing to some more sensitive variety or species. Plants of a European clone of Fragaria vesca have proved satisfactory as indicators. This species not only shows good symptoms when infected with most viruses, but also differentiates certain virus types and their combinations. Descriptions of the virus types encountered in these investigations were based upon symptoms expressed by F. vesca. As the result of indexing, two distinct types of associated symptoms were separated and were designated as type 1 and type 2. Character combinations of the former type vary considerably, but the most prominent show as dwarfing, leaf distortion, crinkling, and chlorotic spotting. Symptoms of type 2 are less variable. Infected indicator plants are dwarfed, the leaves are yellowish-green, smooth, and symmetrical and the petioles are short. Petiole and leaf epinasty is a common character in the early stages of infection, followed by many bud proliferations from the original stem.

It is believed that dispersal of strawberry viruses is accomplished under field conditions principally by three aphid species belonging to the genus Capitophorus. One species, C. fragaefolii (Ckll.), which has long been known as a virus-transmitting form, is reported to be common in the western States and occasional in the East. Two other species, C. minor (Forbes) and an unnamed species resembling C. fragaefolii, seem to be widely distributed in the East and are reported here for the first time as being vectors. Five species of other aphid genera have also been reported capable of transmitting strawberry viruses, but their importance as vectors under field conditions is not known.

The studies herein described were made in connection with a project primarily designed to locate virus-free strawberry plants of the more valuable strawberry varieties to replace the present stocks of infected plants. Virus-free plants of four southern varieties -- Klondike, Klonmore, Tennessee Beauty, and Tennessee Shipper, under test since 1949 -- were the first to be furnished to cooperating nurseries for mass propagation. Ten other varieties considered virus-free (located in 1948, 1949, and 1950) include Armore, Blakemore, Catskill, Corsican, Premier (Howard 17), Fairfax, Massey, Sparkle, Tennessean, and Vermilion. These varieties are suitable for the northern strawberry sections and are now being propagated but will not be ready for distribution before 1953. Fourteen additional varieties, now tentatively considered virus-free but not fully tested, include Aroma, Beaver, Big Joe, Dunlap, Gem, Konvoy, Marion Bell, Mastodon, Midland,

Missionary, Progressive, Robinson, Sioux, Superfection, and Suwannee. Some of these will be ready for nursery propagation in 1953.

Literature Cited


1. Baerg, W. J. Eastern strawberry louse. Arkansas Agr. Exp. Sta. Tech. Bul. 179. 1922.
2. Berkeley, G. W., and A. G. Plakidas. Strawberry leaf roll, a new disease. Phytopath. 32: 631-633. 1942.
3. Demaree, J. B. Diseases of strawberries. U. S. Dept. Agr. Farmers' Bul. 1891. 1941. (revised 1948)
4. _____. Strawberry virus in eastern United States. Phytopath. (Abst.) 36: 684. 1946.
5. _____. Fragaria vesca as an index plant for some virus diseases of strawberry. Phytopath. (Abst.) 40: 870. 1950.
6. Frazier, N. W. New aphid vectors for strawberry viruses. Jour. Econ. Ent. 44: 258-259. 1951
7. Harris, R. V., and Mary E. King. Studies in strawberry virus diseases. V. The use of Fragaria vesca L. as an indicator of yellow edge and crinkle. Jour. Pomol. & Hort. Sci. 19: 227-242. 1942.
8. [ Horne, W. T. ] Strawberry troubles. Calif. Agr. Exp. Sta. Rpt. 1921/22. pp. 122-123.
9. Moore, J. D., J. S. Boyle, and G. W. Keitt. Mechanical transmission of a virus disease to cucumber from sour cherry. Sci. 108: 623. 1948.
10. Plakidas, A. G. Strawberry xanthosis (yellows), a new insect-borne disease. Jour. Agr. Res. 35: 1057-1090. 1927.
11. Stevens, N. E. Strawberry diseases. U.S.Dept. Agr. Farmers' Bul. 1458. 1925 (revised 1933).
12. Thomas, Harold E. The strawberry virus complex. Phytopath. (Abst.) 39: 863. 1949.
13. Vaughan, E. K. Transmission of the crinkle disease of strawberry. Phytopath. 23: 738-740. 1933.
14. Zeller, S. M. Preliminary studies on witches'-broom of strawberry. Phytopath. 17: 329-335. 1927.
15. _____. Crinkle disease of strawberry. Oreg. Agr. Exp. Sta. Bul. 319. 1933.
16. _____. Strawberry diseases in Oregon in 1941. U. S. Dept. Agr. Plant Dis. Reptr. 25: 512-513. 1941.


DIVISION OF FRUIT AND NUT CROPS AND DISEASES, BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING, AGRICULTURAL RESEARCH ADMINISTRATION, U. S. DEPARTMENT OF AGRICULTURE, BELTSVILLE, MARYLAND.

## COMPARISON OF FUNGICIDES FOR CONTROL OF POWDERY MILDEW ON THE LATHAM RED RASPBERRY IN 1950

Robert H. Fulton

Heavy infections of powdery mildew (Sphaerotheca humuli), have been observed periodically in Michigan in past years on certain plantings of red raspberry, particularly of the Latham variety. Many fields showed severe infection during the latter part of the 1950 season. Powdery mildew on raspberry has not been successfully controlled by sprays. Peterson and Johnson (2) reported the use of four different fungicides including 1-40 lime sulfur, 4-4-50 bordeaux mixture, copper-lime dust, and sulfur dust as mildew treatments. In these trials, these fungicides either failed to control mildew or were too injurious for recommendation.

In August 1950, a planting of red raspberry, Latham variety, near Berrien Springs, Michigan, found heavily infected with powdery mildew appeared ideal for evaluating several new materials as mildew eradicants. The planting had received previously only a dormant spray of 1% Elgetol. A series of eight different fungicides including two combinations of materials, all without sticker or spreaders, were selected for testing.

Individual treatments were applied to the raspberries in 100 foot strips in adjacent rows, the remainder of each row, approximately 400 feet long, serving as unsprayed controls. The applications were made on August 5, 15, and 30. The spray was delivered from a 7 gallon per minute pump through a "Friend" spray gun at 200 pounds pressure to provide a soft fog spray. Care was taken to cover the entire plant including the succulent growing tips.

Data were recorded for foliage injury and mildew control in 1950 and for the number of living and dead fruiting canes present in 1951. These data are presented in Table 1. A rating scale was devised, arbitrarily based on numbers from 0 to 5, with the lowest figure representing the least injury or the best control.

Table 1. The effect of fungicides on the Latham red raspberry for the control of powdery mildew.

| Materials | Amount per 100 gallons | 1950 Foliage injury (a) | 1950 Mildew control (b) | 1951 Fruiting Canes Dead | 1951 Fruiting Canes Living |
|---|---|---|---|---|---|
| Ferbam | 1 1/2 lbs. | 0 | 2 | 17 | 106 |
| Mike Sulfur & Ferbam | 3 lbs. & 1 1/2 lbs. | 3 | 3 | 107 | 23 |
| Mike Sulfur | 5 lbs. | 5 | 2 | 123 | 14 |
| Mike Sulfur & Nu Green | 5 lbs. & 5 lbs. | 3 | 3 | 90 | 28 |
| Tag 331 | 1/2 pt. | 3 | 4 | 107 | 7 |
| Zineb | 1 1/2 lbs. | 0 | 5 | 19 | 85 |
| Arathane 25 WP | 1 lb. | 0 | 2 | 14 | 94 |
| 341 SC & Spray Lime | 1 1/2 qts. & 1/2 lb. | 0 | 4 | 10 | 75 |
| Acti-dione | 5 ppm. | 0 | 4 | 13 | 89 |
| Check | none | 0 | 5 | 6 | 97 |

(a) Injury rating: Range, 0 to 5: 0 - no injury; 3 - severe leaflet burning, basal defoliation; 5 - severe leaflet burning resulting in complete defoliation except for terminal tuft of leaves.

(b) Control rating: Range, 0 to 5: 0 - no powdery mildew; 1 - trace of mildew; 2 - slight fungus growth on lower side of leaflets, none on tips; 3 - moderate fungus growth present on both sides of leaflets, none on tips; 4 - fungus growth heavy on both leaflet surfaces and on succulent tips; 5 - fungus growth severe on all surfaces of new growth and older leaflets.

Results of these experiments as given in Table 1, indicate that the sulfur treatments showed control but were injurious to the plants, shown particularly in the final count of dead canes the following season. Although not indicated in the table, foliage injury and basal defoliation of plants in the sulfur plots were noticeable following each application. It was also noticed that plants infected with red raspberry mosaic were more severely injured than normal plants. NuGreen was combined with sulfur with the hope that synergism (3) might be effected. However, this combination was not as effective as sulfur alone for mildew control although it did decrease foliage injury.

Acti-dione resulted in only slight control. The poor showing for this material may result from

the spray lime used in the tank in applications prior to that of Acti-dione. Ford[1] advises through correspondence that Acti-dione is stable in an acid solution and has recorded that it is inactivated by dilute alkali (1).

Tag 331, Crag 341 SC, and zineb either were of little fungicidal value for powdery mildew or were too injurious.

Significant control was noted in both ferbam and Arathane plots. The ferbam-sprayed plants retained more foliage near the ground line and the later formed leaflets were larger.

It may be concluded from these tests that the sulfur applications although showing control are too injurious for recommendation. Ferbam and Arathane thoroughly applied as a post-harvest spray gave decided reduction in powdery mildew infection.

## Literature Cited

1. Leach, B. D., J. H. Ford, and A. J. Whiffen. Acti-dione, an antibiotic of Streptomyces griseus. Journ. Amer. Chem. Soc. 69: 474. 1947.
2. Peterson, P. D., and H. W. Johnson. Powdery mildew of raspberry. Phytopath. 18: 787-796. 1928.
3. Stoddard, E. M. Fungicidal synergism between urea and sulfur. (Abst.) Phytopath. 40: 27. 1950.

DEPARTMENT OF BOTANY AND PLANT PATHOLOGY, MICHIGAN STATE COLLEGE, EAST LANSING

[1]Letter from Dr. J. H. Ford, Upjohn Company, Kalamazoo, Michigan Oct. 19, 1951.

# A FIELD TEST OF SEVERAL FUNGICIDES FOR THE CONTROL OF POWDERY MILDEW ON LUCRETIA DEWBERRY IN 1951

William J. Young and Robert H. Fulton

The Lucretia dewberry is an important fruit in southwestern Michigan, both on the fresh market and in the fruit processing industry. Within the past three years the problem of powdery mildew (Sphaerotheca humuli) has assumed appreciable importance on this crop possibly due in part to an increase in summer rainfall. The presence of considerable mildew in a ten-acre planting of dewberries in 1951 afforded an opportunity to run a field test comparing several fungicides as a continuation of the tests made by Fulton (2) on red raspberry in 1950.

Six materials including Actidione, an antibiotic fungicide (3), were compared as pre-harvest sprays in one and two applications both with and without a spreader, Triton B 1956. Also Acti-dione was tested in one and two applications after harvest. The fungicides and dosages for 100 gallons of spray were: ferbam 1 1/2 lbs., nabam plus zinc sulfate 2 qts., and 1 lb., Crag 341 plus hydrated spray lime 1 1/2 qts. and 1/2 lb., Phygon XL 1/8 lb., Acti-dione plus HCl 2 ppm. and 15 cc., all with and without a spreader, Triton B 1956, 2 ounces. In addition, Triton B 1956 was tested alone at 2 ounces per 100 gallons to determine its individual effectiveness for the control of mildew. These sprays were applied thoroughly at 200 pounds pressure with a "Friend" spray gun and size 6 disc.

Before the experiment was begun, the field had received two sprays applied by the grower, consisting of a delayed dormant lime sulfur and a pre-bloom ferbam application. Apparently these had little effect in controlling the disease. The experimental plots consisted of 50-foot lengths of single rows for each material tested for the first spray, and one half of each row received a second application.

In obtaining the results, field observations were made at one week intervals. An attempt was made to establish an arbitrary rating for the fungicides tested. However, as the season progressed, it was apparent that Acti-dione and nabam-zinc were the only materials giving significant control. This held for approximately two weeks after the applications were made. Nabam-zinc was intermediate in control with the other materials indicating merely a slight reduction in mildew. Triton B 1956 used alone reduced mildew slightly but when combined with the other fungicides it added materially to the control. No foliage injury could be attributed to any of the materials.

In light of the early results, Acti-dione was again tested in post-harvest applications at the rate of 2 and 5 ppm. in slightly acid solution plus Triton B 1956. Observations indicated that no control was obtained for after-harvest sprays.

The data obtained in these trials are presented in Table 1.

Table 1. Arbitrary rating* of mildew control on Lucretia dewberry.

| Materials Tested | Control Rating: 1 Spray | Control Rating: 2 Sprays | After-harvest Eradicant |
|---|---|---|---|
| Acti-dione & HCl | 6 | 8 | 0 |
| Acti-dione & B 1956 & HCl | 8 | 10 | 0 |
| Nabam - Zinc | 3 | 4 | --- |
| Nabam - Zinc & B 1956 | 4 | 5 | --- |
| Crag 341 & Lime | 2 | 3 | --- |
| Crag 341 & Lime & B 1956 | 2+ | 3+ | --- |
| Ferbam | 1 | 2 | --- |
| Ferbam & B 1956 | 1+ | 2+ | --- |
| Triton B 1956 alone | + | 1+ | --- |
| Phygon XL | 0 | 0 | --- |
| Phygon XL & B 1956 | + | 1+ | --- |

*Rating: Range of control represented by numbers 0 to 10; the highest number indicates the greatest control.

DISCUSSION: It is possible that the difference in control indicated here for Acti-dione on dewberry in 1951 and on raspberry by Fulton (2) in 1950 can be accounted for by the addition of acid and Triton B1956. However, when the material was used in an eradicant capacity only it was of little value against powdery mildew on dewberry and on raspberry. Acti-dione has considerable merit as a spray for certain types of mildew control. Felber, et al. (1) reported that Erysiphe

polygoni was apparently killed by a 10 ppm. solution. Vaughn, et al. (5) indicated control of Sphaerotheca pannosa on greenhouse roses using 5 ppm. McClure and Cation (4) reported control of cherry mildew Podosphaera oxyacanthae at concentrations of 2 ppm. As reported in these tests Acti-dione gave the best control of any of the materials tested but the mildew reappeared after treatments were discontinued. Possibly earlier and continued applications would have given a more lasting control of mildew on dewberry.

The little control shown by Phygon XL may have resulted from the extremely weak concentration used.

Literature Cited

1. Felber, M. Irma, and C. L. Hamner. Control of mildew on bean plants by means of an antibiotic. Bot. Gaz. 110. 1948.
2. Fulton, R. H. Comparison of fungicides for control of powdery mildew on the Latham red raspberry in 1950. Plant Dis Reptr. 35:538-539. 1951.
3. Leach, B. D., J. H. Ford, and A. J. Whiffen. Acti-dione, an antibiotic of Streptomyces griseus. Journ. Amer. Chem. Soc. 69: 474. 1947.
4. McClure, T. T., and Donald Cation. Comparison of Acti-dione with some other spray chemicals for control of cherry leaf spot in Michigan. Plant Dis. Reptr. 35: 393-395. 1951.
5. Vaughn, J. R., J. L. Lockwood, G. S. Randwa, and C. L. Hamner. The action of Acti-dione on plant tissues and upon certain fungi. Mich. Agr. Exp. Sta. Quar. Bul. 31: 456-464. 1949.

DEPARTMENT OF BOTANY AND PLANT PATHOLOGY, MICHIGAN STATE COLLEGE, EAST LANSING.

# THE EVALUATION OF MATERIALS FOR HEAT TREATMENT OF PEAS AND BEANS[1]

R. D. Watson, Lewis Coltrin, and Ronald Robinson

Hot water is suitable for heat treatments of tomato, carrot, and cabbage seed for the control of seed-borne pathogens. It is undesirable as a medium for treating peas and beans. Hot water causes the seed-coat of peas and beans to wrinkle and slip making them unfit for seed. We selected a number of different materials for study to find one suitable for heat treating Thomas Laxton peas, Tendergreen beans, and Clarke bush lima beans.

This report deals with the effect of the materials with heat on the seed. Further research will be necessary to evaluate the practical use of the materials and heat on the control of seed-borne pathogens.

## MATERIALS AND METHODS

The materials selected as possible treating agents were: carbon tetrachloride, mineral oil, Shell cleaner, Prestone (ethylene glycol), motor oil (S.A.E. 10), roccal, methyl alcohol, kerosene, xylol. lactic acid solutions, toluene, acetone, glycerine, cedar oil, aniline oil, olive oil, sodium chloride solutions, and cotton seed oil.

The first test consisted of a soak treatment to determine the seed toxicity of the materials. As a rule, the oils were toxic to the seed and were removed from the seed surface in the following heat treatment. The desired heat treatments were conducted in a constant temperature bath. The seeds were put into the temperature bath at various time intervals and all were removed at the end of the treatment. This was done to minimize the usual initial drop in temperature of the bath when a large quantity of seed enter the bath at one time.

## RESULTS AND DISCUSSION

Some materials, such as lactic acid, methyl alcohol, and sodium chloride solutions were eliminated because they caused the seeds to swell and the coats to slip. Methyl alcohol, toluene, and acetone were excluded from further tests because of the fire hazard and because they were less effective than the oils or carbon tetrachloride. Most of the oils, -- cedar, aniline, olive and cotton seed -- were dropped because they reacted similarly to less expensive motor oil. Roccal was excluded because it killed the seeds. In the further exploratory tests, carbon tetrachloride, motor oil (S.A.E. 10), fuel oil, and mineral oil were used. Mineral oil was later excluded since it was no more effective than motor oil and was more costly.

Further experiments were conducted to determine the thermal death point of Thomas Laxton peas, Tendergreen beans, and Clarke bush lima beans when exposed at different temperatures in water, carbon tetrachloride, fuel oil, and motor oil. Lima beans were more resistant to hot water than were the beans and peas, but the germination was severely reduced by longer exposures and higher temperatures. Of those tested, fuel oil reduced the germination of lima beans more than the other materials. Motor oil reacted more like carbon tetrachloride than did the other materials, but the germination of the seeds which were treated in motor oil was reduced due to the penetration of the oils to the extent that motor oil was excluded from final tests (Table 1 & 2). In other experiments, peas, beans, and lima beans were able to withstand treatment in carbon tetrachloride for a considerable time without serious reduction in germination (Table 3).

Carbon tetrachloride possesses several properties that make it the most desirable treating material tested. Seeds tested were able to survive long periods of exposure to heat in carbon tetrachloride without seriously reducing their viability. Carbon tetrachloride is not toxic to the seed and evaporates readily from the seed, leaving no harmful residues. The seed coats do not slip after prolonged immersions in carbon tetrachloride, and it is absorbed but little by the seed. The boiling point is around 76.8°C (167°F). At this temperature, carbon tetrachloride becomes a constant boiling liquid at a given pressure which would eliminate intricate temperature control apparatus for maintaining constant temperatures. Carbon tetrachloride does not present a fire hazard. These factors make it an ideal substance to be used as a heat-treating material.

The specific heat of water is five times greater than the specific heat of carbon tetrachloride. This does not account, however, for the seed being able to survive extended exposures in carbon

[1]Published with the approval of the Director of the Idaho Agricultural Experiment Station as Research Paper no. 343.

TABLE 1. Germination of Tendergreen beans after exposure of 60°C, 70°C, 80°C and 90°C in carbon tetrachloride, motor oil, fuel oil and water.*

| Time of Treatment | Percent of seed germinated after treatment | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 60°C | | | | 70°C | | | | 76.8** | 80°C | | | 90°C | | | |
| | $CCl_4$ | Motor oil | Fuel oil | $H_2O$ | $CCl_4$ | Motor oil | Fuel oil | $H_2O$ | $CCl_4$ | Motor oil | Fuel oil | $H_2O$ | Motor oil | Fuel oil | $H_2O$ |
| 0-Check | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 10 min. | 88 | 96 | 68 | 88 | 88 | 96 | 92 | 84 | 68 | 80 | 60 | 12 | 40 | 40 | 0 |
| 20 min. | 92 | 96 | 68 | 84 | 100 | 88 | 52 | 12 | 76 | 80 | 24 | 0 | 0 | 0 | 0 |
| 30 min. | 100 | 92 | 76 | 44 | 96 | 80 | 84 | 0 | 88 | 52 | 16 | 0 | 0 | 0 | 0 |
| 40 min. | 100 | 100 | 72 | 4 | 100 | 92 | 80 | 0 | 84 | 40 | 16 | 0 | 0 | 0 | 0 |
| 50 min. | 92 | 92 | 68 | 0 | 84 | 96 | 84 | 0 | 76 | 52 | 0 | 0 | 0 | 0 | 0 |
| 60 min. | 96 | 84 | 64 | 0 | 80 | 84 | 56 | 0 | 80 | 12 | 0 | 0 | 0 | 0 | 0 |

TABLE 2. Germination of Lima beans after exposures of 60°C, 70°C. 80°C and 90°C in carbon tetrachloride, motor oil, fuel oil and water.*

| Time of Treatment | Percent of seed germinated after treatment | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 60°C | | | | 70°C | | | | 76.8** | 80°C | | | 90°C | | | |
| | $CCl_4$ | Motor oil | Fuel oil | $H_2O$ | $CCl_4$ | Motor oil | Fuel oil | $H_2O$ | $CCl_4$ | Motor oil | Fuel oil | $H_2O$ | Motor oil | Fuel oil | $H_2O$ |
| 0-Check | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 10 min. | 64 | 72 | 36 | 88 | 68 | 92 | 68 | 100 | 68 | 64 | 12 | 68 | 12 | 4 | 0 |
| 20 min. | 72 | 92 | 24 | 100 | 60 | 56 | 44 | 84 | 84 | 16 | 0 | 12 | 4 | 4 | 0 |
| 30 min. | 60 | 64 | 60 | 100 | 100 | 80 | 16 | 76 | 84 | 0 | 0 | 0 | 0 | 0 | 0 |
| 40 min. | 72 | 52 | 44 | 96 | 72 | 76 | 24 | 60 | 84 | 0 | 0 | 0 | 0 | 0 | 0 |
| 50 min. | 84 | 72- | 20 | 80 | 68 | 60 | 44 | 8 | 84 | 0 | 0 | 0 | 0 | 0 | 0 |
| 60 min. | 56 | 56 | 24 | 60 | 56 | 64 | 28 | 0 | 72 | 0 | 0 | 0 | 0 | 0 | 0 |

* (Peas and beans reacted very similarly and only a representative bean table is reproduced).

** Carbon tetrachloride boils at 76.8°C

TABLE 3. Germination of Superlaska peas, Tendergreen beans, and Lima beans after exposures of 65°C, and 75°C in water and carbon tetrachloride.

| Time of Treatment | Percent of seeds germinated after treatment | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 65°C | | | | | | 75°C | | | | | |
| | Superlaska peas | | Tendergreen beans | | Lima beans | | Superlaska peas | | Tendergreen beans | | Lima beans | |
| | $H_2O$ | $CCl_4$ | $H_2O$ | $CCl_4$ | $H_2O$ | $CCl_4$ | $H_2O$ | $CCl_4$ | $H_2O$ | $CCl_4$ | $H_2O$ | $CCl_4$ |
| 0-Check | 100 | 100 | 98 | 98 | 84 | 84 | 100 | 100 | 100 | 100 | 84 | 84 |
| 10 min. | 90 | 98 | 88 | 92 | 74 | 66 | 94 | 96 | 80 | 90 | 92 | 84 |
| 20 min. | 70 | 86 | 80 | 92 | 78 | 98 | 30 | 98 | 20 | 94 | 88 | 88 |
| 30 min. | 24 | 98 | 62 | 90 | 74 | 90 | 10 | 100 | 2 | 96 | 82 | 88 |
| 40 min. | 18 | 96 | 48 | 84 | 90 | 86 | 0 | 100 | 0 | 96 | 46 | 92 |
| 50 min. | 12 | 98 | 30 | 86 | 80 | 80 | 0 | 100 | 0 | 98 | 30 | 94 |
| 60 min. | 0 | 82 | 12 | 96 | 74 | 82 | 0 | 98 | 0 | 86 | 6 | 90 |

Percentage based on average of two replicates of 25 seeds each.

tetrachloride while they are killed in a relatively short time in hot water. Heat is not transferred as fast from the carbon tetrachloride to the seed as from the water to the seed, although the difference is slight. In a relatively short time the seeds will be as hot in the carbon tetrachloride as will those seeds in the water.

## SUMMARY

Of the materials tested, carbon tetrachloride appeared to be the most suitable treating medium for Tendergreen beans, Thomas Laxton peas and Clarke bush lima beans.

Beans, peas and lima beans were able to survive extended exposures in hot carbon tetrachloride, while they were killed in a relatively short time when exposed in water of the same temperature.

Lima beans were more resistant to hot water than were the peas or beans tested. Hot carbon tetrachloride should be of value in destroying seed-borne organisms in peas and beans.

IDAHO AGRICULTURAL EXPERIMENT STATION

# A CHECK LIST OF THE DISEASES OF ECONOMIC PLANTS OF EL SALVADOR, CENTRAL AMERICA[1]

Bowen S. Crandall, Leopoldo Abrego, and Bernardo Patiño[2]

In this list of diseases that attack the economic plants of El Salvador, those marked with one asterisk were included in John A. Stevenson and Frederick L. Wellman's "A Preliminary Account of the Plant Diseases of El Salvador," published in 1944 in the Journal of the Washington Academy of Science, volume 34, pages 259-268. Those marked with two were identified by the Division of Mycology, Bureau of Plant Industry, Soils, and Agricultural Engineering, United States Department of Agriculture.

AGAVE AMERICANA L. -- HENEQUEN
Colletotrichum agaves Cav.: Anthracnose

AGAVE FOURCROYDES Lem. -- YUCATAN HENEQUEN
*Diplodia theobromae (Pat.) Nowell: Black leaf spot

AGAVE LETONAE Trel. -- HENEQUEN, LOCAL VARIETY
*Colletotrichum agaves Cav.: Anthracnose
*Diplodia theobromae (Pat.) Nowell: Black leaf spot
**Dothidella parryi (Farl.) Th. & Syd.
**Septonema agaves Stevenson

AGAVE SISALANA Perr. -- HENEQUEN
*Diplodia theobromae (Pat.) Nowell: Black leaf spot

AGAVE sp. -- WILD HENEQUEN
*Dothidella parryi (Farl.) Th. & Syd.

ALLIUM CEPA L. -- ONION
*Alternaria porri (Ell.) Saw.: Purple blotch

ALLIUM PORRUM L. -- LEEK
*Alternaria porri (Ell.) Saw.: Purple blotch

ALTHAEA ROSEA Cav. -- HOLLYHOCK
*Virus: Mottling yellow and green

ANANAS COMOSUS (L.) Merr. -- PINEAPPLE
Cephalosporium sp.: Leaf spot
Phythophthora parasitica Dast.: Heart rot
Pythium sp.: Root rot

ANDIRA JAMAICENSIS (W. Wright) Urb. -- CABBAGE ANDIRA
*Gloeosporium sp.: Anthracnose
*Polystigma pusillum Syd.: Angular leaf spot

ANNONA RETICULATA L. -- ANNONA
Cephalosporium sp. (Nov.): Target spot
**Elsinoë annonae Bitanc. & Jenkins: Scab

ARACHIS HYPOGAEA L. -- PEANUT
Cercospora personata (Berk. & Curt.) Ell. & Ev.: Leaf spot

[1]A contribution from the Centro Nacional de Agronomía, a technical agricultural service organization for El Salvador, operated jointly by the Ministry of Agriculture of El Salvador and the Office of Foreign Agricultural Relations, U. S. Department of Agriculture. United States participation in this work was carried out as part of the Point Four program in El Salvador, administered by the Technical Cooperation Administration, U. S. Department of State.

[2]Respectively, senior pathologist, U. S. Department of Agriculture, and the subchief and the assistant subchief of the Department of Plant Pathology, Centro Nacional de Agronomía.

BAUHINIA PAULETIA Pers.
Uromyces jamaicensis Vest.: Rust

BAUHINIA UNGULATA L.
*Uromyces guatemalensis Vest.: Rust

BETA VULGARIS L. -- BEET
Rhizoctonia solani Kuehn: Damping off and root rot

BETA VULGARIS var. CICLA L. -- SWISS CHARD
*Cercospora beticola Sacc.: Leaf spot

BOEHMERIA NIVEA (L.) Gaud. -- RAMIE
* Virus stunting and mottling

BRASSICA CHINENSIS L. -- CHINESE CABBAGE

BRASSICA OLERACEA var. BOTRYTIS L. -- BROCCOLI
Rhizoctonia solani Kuehn: Damping-off

BRASSICA OLERACEA var. BOTRYTIS L. -- CAULIFLOWER
*Alternaria brassicae (Berk.) Sacc.: Black leaf spot

BRASSICA OLERACEA var. CAPITATA L. -- CABBAGE
*Alternaria brassicae (Berk.) Sacc.: Black leaf spot

BRASSICA OLERACEA var. ACEPHALA L. -- KALE
Rhizoctonia sp.: Collar rot

BROMELIA KARATAS L.
* Perisporium bromeliae F.L. Stevens: Sooty mold.

CALOPHYLLUM BRASILIENSE var. REKOI Standl. -- BARILLO
Cephalosporium sp.: Vascular wilt

CANAVALIA ENSIFORMIS (L.) DC. -- JACKBEAN
Rhizoctonia sp.: Root rot
Sclerotium rolfsii Sacc.: Collar rot

CAPSICUM FRUTESCENS var. GROSSUM (L.) Bailey -- BELL PEPPER
*Cercospora capsici Heald & Wolf: Leaf spot
*Cercospora diffusa Ell. & Ev.: Brown leaf spot
Rhizoctonia solani Kuehn: Damping off
Rhizoctonia sp.: Fruit rot, sand splash
*Virus disease resembling tobacco mosaic

CAPSICUM FRUTESCENS var. LONGUM (DC.) Bailey -- CHILE
Phytophthora cactorum (Leb. & Cohn) Schroet: Fruit rot
Virus disease resembling beet curly top

CARICA PAPAYA L. -- PAPAYA
*Oidium caricae Noack: Powdery mildew
*Pucciniopsis caricae (Speg.) Earle (Asperisporium caricae (Speg.) Maub.
Rhizopus sp. associated with fruit fly-rot of fruit
*Virus disease resembling bunchy top

CASSIA sp. -- SENNA
*Rhizoctonia solani Kuehn: Damping off

CENTROSEMA PUBESCENS Benth.
*Uromyces neurocarpi Diet.: Rust

CITRULLUS VULGARIS Schrad. -- WATERMELON
Erysiphe cichoracearum DC.: Powdery mildew (Oidium stage)
*Pseudoperonospora cubensis (Berk. & Curt.)Rostow.: Downy mildew

CITRUS AURANTIFOLIA (Christm.) Swingle -- LIME
*Cephaleuros virescens Kunze: Algal leaf spot
Cephalosporium sp.: Twig die back
*Elsinoë fawcetti Bitanc. & Jenkins: Scab -- leaf & fruit
*Mycosphaerella sp.: leaf spot

CITRUS AURANTIUM L. -- SOUR ORANGE
Elsinoë fawcetti Bitanc. & Jenkins: Scab
Phytophthora parasitica Dast.: Gummosis
Rhizoctonia solani Kuehn: Collar rot, late damping-off.

CITRUS LIMONIA (L.) Burm. f. -- SWEET LEMON
**Cephaleuros virescens Kunze: Stem Cankers
Cephalosporium sp.: Tip die back
Phytophthora parasitica Dast.: Gummosis

CITRUS MEDICA L. -- CITRON
Phytophthora parasiticia Dast.: Gummosis

CITRUS RETICULATA Blanco -- MANDARIN
Cephalosporium sp.: Tip die back
Sclerotium bataticola Taub.: Seedling collar rot

CITRUS SINENSIS (L.) Osbeck -- SWEET ORANGE
Cephalosporium sp.: Brown fruit rot
Corticium salmonicolor Berk. & Br.: Pink disease
Diplodia theobromae (Pat.) Nowell: Aerial gummosis
Phytophthora parasitica Dast.: Gummosis
Pseudomonas syringae v. Hall: Blast
Psorosis-virus, brown stain in wood
**Septobasidium curtisii (Berk. & Desm.) Boed. & Steinm.: Felt
**S. pseudopedicellatum Burt: Felt

COCOS NUCIFERA L. -- COCONUT
*Diplodia cococarpa Sacc.: On husks
Diplodia theobromae (Pat.) Nowell: Gummosis of trunk
*Exosporium palmivorum Sacc.: Leaf spots (on dead leaves)
*Leptosphaeria sp.: On leaf tips
Nematode red ring
*Pestalotia palmarum Cke.: Grey-brown leaf spots

CODIAEUM VARIEGATUM (L.) Blume -- ORNAMENTAL CROTON
*Gloeosporium sorauerianum Allesch.: Anthracnose

COFFEA ARABICA L. -- COFFEE
*Capnodium coffeae Pat.: Sooty mold
Cephalosporium sp.: Die back and cherry decay
Cephalosporium sp.: Die back (citrus type)
*Cercospora coffeicola Berk. & Cke.: Leaf spot
*Colletotrichum coffeanum Noack: Anthracnose
Fusarium coffeicola P. Henn.: Leaf spot
**Helicobasidium compactum Boedijn: Felt
*Heterodera marioni (Cornu) Goodey: Nematode root-knot
*Micropeltis applanata Mont.: Fly-speck fungus
*Mycosphaerella coffeicola Cke.: Leaf spot
Nectria dodgeii Heiser: Die back and cherry decay
*Omphalia flavida Maubl. & Rangel.: Leaf spot
**Pellicularia filamentosa (Pat.) Rogers: Collar sporophore associated with soft yel
low phloem decay
**Poria sp.: From tree with root rot

Rhizoctonia solani Kuehn: Damping off
Rhizoctonia sp.: Black root rot

CROTALARIA VITELLINA Ker. -- CROTALARIA
Cephalosporium sp.: Die back
Nectria dodgeii Heiser: Die back
Pellicularia filamentosa (Pat.) Rogers: Root rot
Rhizoctonia sp.: Collar rot

CUCUMIS MELO L. -- MELON
Erysiphe cichoracearum DC: Powdery mildew
Pseudoperonospora cubensis (Berk. & Curt.) Rostow.: Downy mildew

CUCUMIS SATIVUS L. -- CUCUMBER
*Erysiphe cichoracearum DC: Powdery mildew
*Pseudoperonospora cubensis (Berk. & Curt.) Rostow.: Downy mildew
*Virus: Corrugated leaves, vein clearing

CUCURBITA MAXIMA Duch. -- SQUASH
*Cercospora cucurbitae Ell. & Ev.: Leaf spot
*Erysiphe cichoracearum DC.: Powdery mildew

CUCURBITA PEPO L. -- GOURD
*Erysiphe cichoracearum DC.: Powdery mildew
*Virus: Mottling

CYMBOPOGON NARDUS (L.) Rendle -- CITRONELLA GRASS
*Virus (Marmor sacchari Holmes): Sugar cane mosaic virus

CYNODON DACTYLON (L.) Pers. -- BERMUDA GRASS
*Helminthosporium giganteum Heald & Wolf: Leaf spot
*Puccinia cynodontis Delacr.: Leaf rust

DALBERGIA GRANADILLO Pittier -- LEGUMINOUS SHADE TREE
Bacterial wet wood and slime flux

DATURA STRAMONIUM L. -- DATURA
*Alternaria crassa (Sacc.) Rands: Leaf spot
*Virus, causing chlorosis

DAUCUS CAROTA L. -- CARROT
*Alternaria carotae Ell. & Langl.: Leaf blight
Rhizoctonia solani Kuehn: Damping off

DESMODIUM sp. -- DESMODIUM
*Alternaria sp.: Leaf spot
*Cercospora desmodii Ell. & Kell.: Leaf spot
*Isariopsis caespitosa Petr. & Cif.: Angular leaf spot

DESMODIUM BARCLAYI Benth. -- DESMODIUM
*Uromyces hedysari-paniculati (Schw.) Farl.: Leaf rust

DESMODIUM NICARAGUENSE Benth. & Oerst. (including D. rensoni Painter) -- DESMODIUM
*Parodiella perisporioides (Berk. & Curt.) Speg.: Leaf spot
Rhizoctonia sp.: Root rot
*Uromyces hedysari-paniculati (Schw.) Farl.: Leaf rust
*Virus: Leaf mottling

DESMODIUM SCORPIURUS (Sw.) Desv. -- DESMODIUM
*Uromyces hedysari-paniculati (Schw.) Farl.: Leaf rust

DIOSCOREA sp. -- YAM
Rhizoctonia microsclerotia Matz: Target spot

DOLICHOS LABLAB L. -- COVER CROP
Rhizoctonia microsclerotia Matz: Web blight

ENTEROLOBIUM CYCLOCARPUM (Jacq.) Griseb. -- CONACASTE
Rhizoctonia sp.: Damping off of late collar rot type

EPIDENDRUM DIFFORME Jacq. -- ORCHID
*Uredo guacae Mayor: Leaf rust

EUPHORBIA PULCHERRIMA Willd. -- POINSETTIA
*Oidium sp. (Sphaerotheca euphorbiae Cast.): Powdery mildew

FICUS CARICA L. -- FIG
*Physopella fici (Cast.) Arth.: Leaf rust (Uredo stage)

FRAGARIA CHILOENSIS Duch. -- STRAWBERRY
*Mycosphaerella fragariae (Tul.) Lindau

FURCRAEA sp. -- HENEQUEN
*Colletotrichum agaves Cav.: Anthracnose
*Dothidella parryi (Farl.) Th. & Syd.: Leaf spot
*Trichocladium olivaceum Mass.: Leaf spot

GLIRICIDIA SEPIUM H.B.K. -- MADRE DE CACAO
*Cyphella villosa Pers. ex Karst.: Die-back twig
*Fusarium decemcellulare Brick: Stem canker
*Isariopsis sp.: Dark brown leaf spot
*Phomopsis sp.: Twig die back
*Rosellinia pepo Pat.: Black root rot

GOSSYPIUM sp. -- COTTON
Mosaic
**Mycosphaerella areola Ehrlich & Wolf (Ramularia stage, R. areola Atk.): Areolate mildew
Phytophthora cactorum (Leb. & Cohn) Schroet.: Boll rot
Rhizoctonia microsclerotia Matz: Blight & boll rot
Sclerotium rolfsii Sacc.: Seedling collar rot

HIBISCUS CANNABINUS L. -- KENAF
Mosaic-virus
*Oidium sp.: Powdery mildew
Pellicularia filamentosa (Pat.) Rogers: Leaf spot
Phytophthora parasitica Dast.: Collar rot
Rhizoctonia sp.: Collar rot
Sclerotium rolfsii Sacc.: Collar rot combined with nematode attack
*Vermicularia dematium Fr.: Collar canker

HIBISCUS SABDARIFFA L. -- ROSELLE
Pellicularia filamentosa (Pat.) Rogers: Leaf spot

INDIGOFERA ENDECAPHYLLA Jacq. -- INDIGOFERA
Rhizoctonia sp.: Root rot

INGA EDULIS Mart. -- PEPETO NEGRO; COFFEE SHADE
Diplodia theobromae (Pat.) Nowell: Collar rot
**Ravenelia ingae (P. Henn.) Arth.: Rust
Virus: Witches broom

INGA PREUSSII Harms -- INGA COFFEE SHADE
*Perisporium truncatum F. L. Stevens: Black mildew
*Ravenelia ingae (P. Henn.) Arth.: Rust

INGA sp. -- INGA COFFEE SHADE
*Ravenelia ingae (P. Henn) Arth.: Rust
*Virus: Leaf mottling

IPOMOEA BATATAS (L.) Lam. -- SWEETPOTATO
Rhizopus nigricans Ehr. ex Fr.: Soft rot

LACTUCA SATIVA L. -- LETTUCE
Rhizoctonia solani Kuehn: Sand splash
*Septoria lactucae Pk.: Leaf spot

LYCOPERSICON ESCULENTUM Mill. -- TOMATO
*Cladosporium fulvum Cke.: Leaf mold
Pythium sp.: Wilt
Rhizoctonia solani Kuehn: Sore-shin
Rhizoctonia sp.: Fruit-rot, sand splash
*Septoria lycopersici Speg.: Leaf spot
Virus: Causing yellow dwarfing resembling beet curly top

MALVASTRUM COROMANDELIANUM (L.) Garcke -- ESCOBILLA
Virus: Mosaic

MANGIFERA INDICA L. -- MANGO
*Colletotrichum gloeosporioides (Penz.) Sacc.: Anthracnose
**Elsinoë mangiferae Bitanc. & Jenkins: Scab
Erysiphe sp.: Powdery mildew
*Phyllosticta mortoni Fairman: Grey leaf spot

MANIHOT ESCULENTA Crantz. -- YUCA
*Cercospora henningsii Allesch.: Leaf spot
*Oidium manihotis P. Henn.: Powdery mildew
*Phyllosticta sp.: Leaf spot
*Virus: Mottling

MEDICAGO SATIVA L. -- ALFALFA
*Xanthomonas alfalfae (Riker, F. R. Jones, & Davis) Dowson: Leaf spot
*Cercospora sp. (C. zebrina Pass.): Leaf spot
*Rhizoctonia sp.: Bleached spots on stems
*Uromyces striatus Schroet.: Leaf rust

MELICOCCA BIJUGA L. -- SPANISH LIME
*Virus: Leaf mottling

MELILOTUS ALBA var. ANNUA Coe -- EMERALD SWEET CLOVER
Rhizoctonia microsclerotia Matz: Web blight

MUSA PARADISIACA L. -- BANANA
*Cercospora musae Zimm.: Sigatoka leaf spot
*Cordana musae (Zimm.) Hoehn.: Leaf spot on Cavandish

NICOTIANA TABACUM L. -- TOBACCO
Pythium sp.: Seedling damping off, black collar rot
Virus: Mosaic

ORYZA SATIVA L. -- RICE
Helminthosporium oryzae V. B. de Haan: Brown spot
Piricularia oryzae Briosi & Cav.: Blast

Rhizoctonia oryzae Ryker & Gooch: White leaf blotch. Diplodia theobromae (Pat.) Nowell also associated

PACHYRHIZUS EROSUS (L.) Urb. -- YAM BEAN
**Erysiphe polygoni DC. (Oidium stage): Powdery mildew

PACHYRHIZUS sp. -- JICAMA
*Isariopsis griseola Sacc.: Angular leaf spot

PANICUM MAXIMUM Jacq. -- GUINEA GRASS
*Cercospora fusimaculans Atk.: Leaf spot

PANICUM PURPURASCENS Raddi. -- PARA GRASS
*Uromyces leptodermus Syd.: Leaf rust

PASPALUM sp.
*Claviceps paspali F.L. Stevens: Ergot

PASSIFLORA QUADRANGULARIS L. -- GRANADILLA
*Cercospora regalis Tharp: Leaf spot

PERSEA AMERICANA Mill. -- AVOCADO
*Cercospora purpurea Cke.: Leaf spot
**Colletotrichum gloeosporioides Penz.: Anthracnose
Sclerotium rolfsii Sacc.: Seedling root rot

PERSEA SCHIEDEANA Nees -- AVOCADO RELATIVE
*Cephaleuros virescens Kunze: Algal leaf spot
*Strigula complanata Fee: Leaf lichen

PETROSELINUM CRISPUM (Mill.) Nym. -- PARSLEY
*Cercospora apii Fres.: Leaf spot

PHASEOLUS LUNATUS L. -- LIMA BEAN
*Elsinoë phaseoli Jenkins: Scab

PHASEOLUS MUNGO L. -- MUNG BEAN
Rhizoctonia microsclerotia Matz: Web blight

PHASEOLUS VULGARIS L. -- BEAN
*Chaetoseptoria wellmanii Stevenson: Leaf spot
Erysiphe polygoni DC.: Powdery mildew
*Isariopsis griseola Sacc.: Angular leaf spot
*Myrmaecium roridum Tode.: Pod spot
*Periconia pycnospora Fres.: Pod spot
Rhizoctonia solani Kuehn: Stem canker and collar rot
Sclerotium rolfsii Sacc.: Seedling collar rot
*Uromyces phaseoli typica Arth.: Bean rust
*Vermicularia polytricha Cke.: Pod spot

PHOENIX sp. -- PALM
*Graphiola phoenicis (Moug.) Poit.: False smut

PISUM SATIVUM L. -- PEAS
Rhizoctonia solani Kuehn: Pod rot and collar rot

PITHECELLOBIUM DULCE (Roxb.) Benth.
*Microstroma pithecolobii Lamkey: Leaf mold
*Virus: Yellow mottling

PITHECELLOBIUM SAMAN (Jacq.) Benth. -- CENICERO

Rhizoctonia sp.: Damping-off of late collar rot type

PRUNUS PERSICA (L.) Batsch -- PEACH
*Darluca filum (Biv.) Cast.: Parasitic on rust
*Tranzschelia pruni-spinosae (Pers.) Diet.: Leaf rust

PSIDIUM GUAJAVA L. -- GUAVA
*Meliola psidii Wint.: Black mildew

PUNICA GRANATUM L. -- POMEGRANATE
*Cercospora punicae Syd.: Leaf spot

RAPHANUS SATIVUS L. -- RADISH
*Albugo candida Pers. ex Kuntze: White rust

RICINUS COMMUNIS L. -- CASTOR BEAN
*Cercospora ricinella Sacc. & Berl.
Rhizoctonia solani Kuehn: Sore-shin

ROSA sp. -- ROSE
*Actinonema rosae (Lib.) Fr.: Black spot
*Cercospora puderi B. H. Davis: Small spots, grey centers
*Diplodia sp.: Dieback
*Stilbella cinnabarina (Mont.) Wr.: Dieback

RUBUS sp. -- BLACKBERRY
*Elsinoë veneta (Burk.) Jenkins: Anthracnose

RUBUS ADENOTRICHOS Schlecht. -- BLACKBERRY
*Spirechina rubi (Diet. & Holw.) Holw.: Rust

SACCHARUM OFFICINARUM L. -- SUGARCANE
*Leptosphaeria sacchari V.B. de Haan: Ring spot
Pythium sp.: Associated with frog hopper injury to roots
*Virus: Mosaic

SALIX CHILENSIS Mol. -- WILLOW
*Melampsora abieti-capraearum Tub.: Rust

SECHIUM EDULE Sw. -- CHAYOTE
*Rhagadolobium cucurbitacearum (Rehm) Th. & Syd.

SESAMUM INDICUM L. -- SESAME
Alternaria sp.: Leaf blast (and fruit)
Sclerotium rolfsii Sacc.: Collar rot

SOIL ONLY (in Coffee Finca)
Phytophthora citrophthora (R.E. & E.H. Sm.) Leonian

SOLANUM MELONGENA L. -- EGGPLANT
Rhizoctonia sp.: Collar rot
Rhizoctonia solani Kuehn: Damping-off

SOLANUM NIGRUM L.
*Cercospora diffusa Ell. & Ev.: Black leaf spot

SOLANUM TORVUM Sw.
*Cercospora solani-torvi Frag. & Cif.: Leaf spot

SOLANUM TUBEROSUM -- POTATO
Rhizoctonia solani Kuehn: Wilt and collar rot

SORGHUM HALEPENSE (L.) Pers. -- JOHNSON GRASS
*Cercospora sorghii Ell. & Ev.: Leaf spot
*Gloeocercospora sorghi Bain & Edgerton: Leaf blotch
*Helminthosporium turcicum Pass.: Spot
*Puccinia purpurea Cke.: Rust

SORGHUM SUDANENSE (Piper) Stapf -- SUDAN GRASS
*Cercospora sorghi Ell. & Ev.: Leaf spot
Puccinia purpurea Cke.: Rust

SORGHUM VULGARE Pers. -- SORGHUM
*Cercospora sorghi Ell. & Ev.: Leaf spot
*Colletotrichum graminicolum (Ces.) G.W.Wils.: Anthracnose
*Helminthosporium turcicum Pass.: Leaf spot
*Puccinia purpurea Cke.: Leaf spot
*Virus: Sugar cane mosaic

STIZOLOBIUM PRURIENS (Stickm.) Medic. -- PICA PICA
Cotton mosaic virus
Rhizoctonia microsclerotia Matz: Web-blight

TECOMA STANS (L.) H.B.K. -- ORNIM TREE
*Prospodium appendiculatum (Wint.) Arth.: Rust

TETRAGONIA EXPANSA Murr. -- NEW ZEALAND SPINACH
*Cercospora tetragoniae Speg.: Leaf spot

THEA SINENSIS L. -- TEA
Pythium sp.: Seedling root rot

TRIFOLIUM spp. -- CLOVERS (T. incarnatum, Dixie Crimson; T. resupinatum, Persian; T. pratense, red; T. dubium, hop; T. repens, white; T. hirtum)
Diplodia theobromae (Pat.) Nowell: Web blight

TRITICUM AESTIVUM L. -- WHEAT
*Puccinia rubigo-vera tritici (Erikss. & E. Henn) Carleton: Common leaf rust
*Septoria tritici Rob.

VIGNA SINENSIS (Torner) Savi -- COWPEA
*Cercospora canescens Ell. & G. Martin: Leaf spot
*Chaetoseptoria wellmanii Stevenson: Leaf spots
*Erysiphe polygoni DC.: Powdery mildew
Pellicularia filamentosa (Pat.) Rogers (Rhizoctonia microsclerotia Matz): Web blight

VITIS VINIFERA L. -- GRAPE
*Alternaria vitis Cav.: Leaf spot
*Mycosphaerella sp.: Leaf spots
*Physopella vitis (Thuem.) Arth.: Rust

YUCCA ELEPHANTIPES Regel -- IZOTE
*Didymosphaeria sp.: Leaf spots
*Gloeosporium yuccigenum Ell. & Ev.: Anthracnose
*Leptosphaeria obtusispora Speg.: Leaf blotch
*Sphaerodothis pringlei (Pk.) Th. & Syd.: Tar spot

ZEA MAYS L. -- CORN
*Angiopsora zeae Mains: Rust
*Cercospora sorghi Ell. & Ev.: Leaf spot
*Cladosporium herbarum Lk.: Leaf spot
*Curvularia geniculta (Tracy & Earle) Boedijn: Leaf spot
*Darluca filum (Biv.) Cast., overgrowing Puccinia sorghi

*Diplodia zeae (Schw.) Lév.: Ear rot
*Fusarium sp.: Ear rot
*Helminthosporium turcicum Pass.: Leaf spot
*Nigrospora oryzae (Berk. & Br.) Petch: Leaf spot
*Physoderma zeae-maydis Shaw: Brown spot
*Puccinia pallescens Arth.: Rust
*Puccinia polysora Underw.: Rust
*Puccinia sorghi Schw.: Rust
*Ustilago maydis (DC.) Cda.: Corn smut
*Virus: Leaf mottling

ZINNIA ELEGANS Jacq. -- ZINNIA
*Cercospora zinniae Ell. & G. Martin: Leaf spot

CENTRO NACIONAL DE AGRONOMIA, EL SALVADOR

# PERITHECIA PRODUCED IN AN UNPAIRED ISOLATE OF CHALARA QUERCINA AND ITS POSSIBLE SIGNIFICANCE IN OAK WILT CONTROL

George H. Hepting, E. Richard Toole, and John S. Boyce, Jr.

During the course of scouting for oak wilt in the Southern Appalachians in 1951, fungus isolations were attempted from suspected trees. Twenty-nine isolates of Chalara quercina from 28 separate areas resulted from this work. When these tissue cultures were plated, the cultures from only one tree, 419, produced perithecia without being paired with or spermatized by any other culture. But perithecia were produced in other cultures when properly paired[1] or spermatized. Tree 419, not yet dead, is under observation for perithecial development.

The fungus in tree 419 is probably either homothallic and self-fertile, or is composed of plus and minus thalli, which act as male and female and which are present in the tree as a result of inoculation with spores of the two sexes. Although tissue cultures of the fungus from tree 419 alone are self-fertile, the fungus acts only as a male when paired with other isolates.

Conidia from a male culture will act as spermatia, when applied to a female culture with a loop or needle, and perithecia oozing ascospores will appear in as short a time as three days at room temperature on acorn or chestnut agar.

Tree 419 may be highly significant from the control standpoint. Possibly such trees produce perithecia and ascospores which may be the important source of inoculum for aboveground spread The ascospores are embedded in a mucoid matrix, almost insoluble in water, but sticky and ideal ly suited for insect or bird transmission, whereas the conidia are not so well equipped.

Possibly only trees bearing perithecia, as a result of either homothallism or male and female strains together, are a major hazard in aboveground spread. If this is true, then trees with unisexual thalli, whether male or female, possibly are relatively less important from the standpoint of aboveground spread. Cultures from each infection focus can be determined as to sex and compatability in two to three weeks on chestnut or acorn agar. Sexuality of the fungus presumably is not related to its spread from tree to tree through grafted roots.

The above interpretations, following the finding of fertile perithecia in the isolate from tree 419, are subject to change and qualifications as new facts become available. However, because of their potential importance they are presented now, in advance of additional work, to make this information available to others currently conducting research on oak wilt. Pending further study, no change in eradication policy is proposed.

Single conidial and ascospore cultures have been made from isolate 419 and should soon provide evidence on whether the tree was inoculated with a homothallic, a male and a female, or two self-sterile but cross-fertile hermaphroditic forms of the fungus.

DIVISION OF FOREST PATHOLOGY, BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING, ASHEVILLE, NORTH CAROLINA

[1] Bretz, T. W. A preliminary report on the perithecial stage of Chalara quercina Henry. Plant Dis. Reptr. 35: 298-299. 1951.

## NEW AND UNUSUAL RECORDS OF PLANT DISEASE OCCURRENCE

### A WITCHES'-BROOM OF LILAC

By Philip Brierley

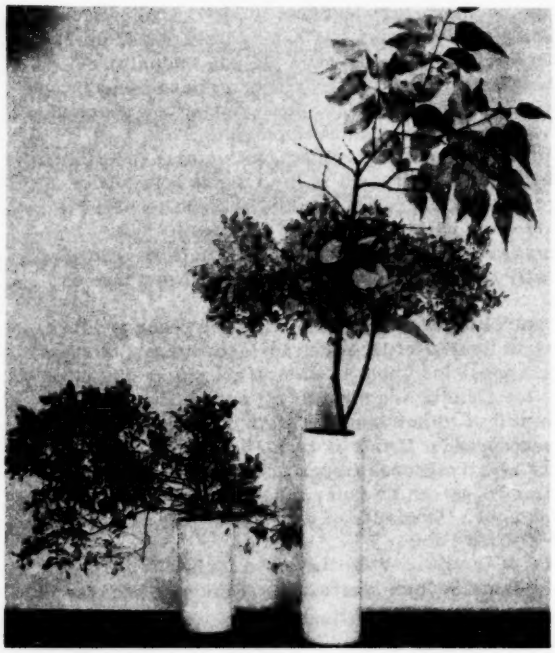


FIGURE 1. Witches'-broom of lilac. Two branches with extensive brooming, the branch on the right showing a normal shoot and a few normal leaves among the brooms. Photographed October 15, 1951 by W. J. Mead.

In September 1951 Miss Marguerite S. Wilcox, of this Bureau, brought from a yard in Takoma Park, Maryland, specimens of a witches'-broom of Japanese lilac (Syringa sp.). The affected tree is perhaps 30 years old, some six inches in diameter at the base, with seven branches attaining a height of about 25 feet. It is not known how long the brooming has been evident, for the lilac is crowded among other trees and shrubs and was not examined until recently.

Symptoms are typical brooming. Lateral buds give rise to two to six slender shoots which branch freely and bear small leaves, one-fourth the length of normal ones or even less. The small leaves are usually normal in shape; but occasionally they are twisted or rolled, and a few are nearly filiform. Brooms occupy most of the top of the plant; but a few lateral branches are free from them, and some nearly normal leaves are scattered along the broomed shoots. Some of these normal leaves show lighter green chlorotic flecks and there is some distortion of the leaf surface. The general appearance of the disease is shown in the accompanying figure.

No disease of this type in lilac is on record as far as known here. The symptoms and the absence of visible pathogens suggest that the cause is a virus, but proof is lacking.

BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING, UNITED STATES DEPARTMENT OF AGRICULTURE, BELTSVILLE, MARYLAND.

### XYLOPOROSIS OF CITRUS IN FLORIDA

By E. P. DuCharme and R. F. Suit

Xyloporosis, a disease of citrus trees budded on sweet lime rootstock, has been known since 1928 in Palestine and 1938 in Brazil and Argentina. Typical symptoms of xyloporosis were recognized in Florida this past summer in trees budded on a so-called sweet lemon rootstock the exact classification of which has not been established. There is a possibility that it may be a sweet lime instead of a sweet lemon, but will be called a sweet lemon in this discussion. The symptoms of xyloporosis were first observed in several groves involving the following cion-stock combinations: Hamlin, Jaffa, Lue Gim Gong, and Valencia varieties of sweet oranges, and Ruby Red grapefruit on the above-mentioned sweet lemon rootstock.

The disease was first noticed in an 80-acre grove of sweet oranges on this rootstock in March 1949 and the trouble was identified as xyloporosis in August 1951. Forty acres had been planted to Hamlin early oranges in 1941 and 40 acres to Lue Gim Gong late oranges in 1942, all of the trees being sweet lemon root except one row of Lue Gim Gong oranges on rough lemon stock which was planted in 1941. All trees in the grove were visibly affected or had symptoms of xyloporosis except for a few Hamlin orange trees and the Lue Gim Gong oranges on rough lemon root. The unaffected trees were twice the size of the diseased trees and had three to four times the bearing surface. The budwood for these trees had been obtained from 25-year-old

apparently healthy trees on rough lemon rootstock.

Xyloporosis has probably been present in Florida for many years, but became evident only when susceptible cion-stock combinations were made with infected buds. At present xyloporosis is not of major importance in the Florida industry because this sweet lemon is not a commonly used rootstock. If it were to be generally adopted, which is not likely, xyloporosis would be a problem. Up to the present xyloporosis has been found in scattered groves in ten counties. More groves may develop symptoms of xyloporosis during the next few years because a number of small plantings on the susceptible rootstock have been set out since 1947.

UNIVERSITY OF FLORIDA CITRUS EXPERIMENT STATION, LAKE ALFRED, FLORIDA

## KNOWN DISTRIBUTION OF OAK WILT IN MICHIGAN

By Forrest C. Strong

FIGURE 1. Oak wilt in Michigan as of October 15, 1951.

Following the aerial survey in July of the two southern tiers of counties by the Michigan State Conservation Department, checking of dead and dying oaks has been carried on by ground crews consisting of foresters of the Division of Forestry and the Division of Parks of the State Conservation Department, plant inspectors of the Bureau of Plant Industry, State Department of Agriculture, and members of the Michigan State College. To date 32 locations of oak wilt (Chalara quercina) have been found, and confirmed by laboratory isolation of the causal fungus. These locations are scattered through 12 counties, with the greatest concentration in the south central part of the State. The number of locations per county are as follows: Berrien 2, Cass 3, St. Joseph 6, Hillsdale 2, Lenawee 1, Van Buren 1, Kalamazoo 4, Calhoun 5, Jackson 2, Washtenaw 3, Oakland 1, Barry 2 (Fig. 1).

In addition to locations spotted from the air, several have been found before and since the aerial survey from independent ground observations.

The age of the earliest killed trees in some locations appears to range from three to ten years as estimated by dead oaks in the vicinity of confirmed oak wilt infected or killed trees.

DEPARTMENT OF BOTANY AND PLANT PATHOLOGY, MICHIGAN STATE COLLEGE

## ASCOCHYTA GOSSYPII IN TEXAS

By L. S. Bird

During 1950 Ascochyta blight was observed on cotton in Navarro and Burleson Counties and was determined to be present in Lubbock County by examing specimens which were sent in by Mr. D. L. Jones.[1] Ascochyta gossypii[2] was isolated from diseased material from the three locations.

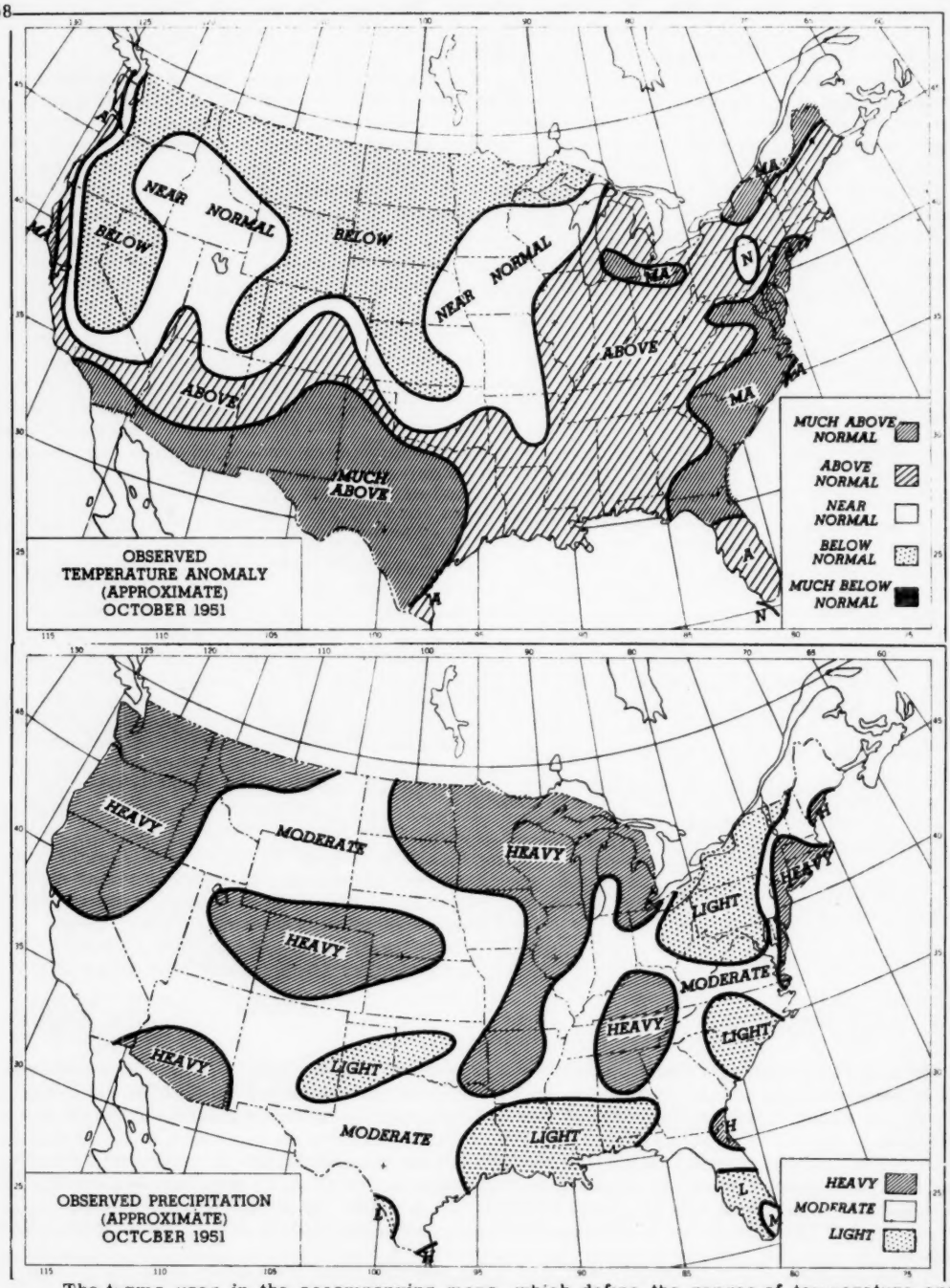
The disease was confined largely to the blades of leaves. Occasionally small lesions were observed on petioles and fruiting branches. Considerable leaf shedding was seen in connection with the disease in bottom land plantings along the Brazos River in Burleson County.

Ascochyta blight occurred also on cotton plants grown in greenhouses at College Station during 1950-51.

DEPARTMENT OF PLANT PATHOLOGY AND PHYSIOLOGY, TEXAS A. & M. COLLEGE SYSTEM; AND DIVISION OF COTTON AND OTHER FIBER CROPS AND DISEASES, BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING, U. S. DEPARTMENT OF AGRICULTURE, COLLEGE STATION, TEXAS

[1]Superintendent, Substation No. 8, Texas Agricultural Experiment Station, Lubbock, Texas.

[2]The identification of the fungus was confirmed by Dr. C. H. Arndt, Botany Department, Clemson College Clemson, South Carolina.




The terms used in the accompanying maps, which define the ranges of temperature and precipitation, are numerical class limits. These are based on a statistical analysis of past records through which is determined the normal frequency of occurrence of temperatures and precipitation at various times of the year for different locations. For temperature the classes above, below, and near normal are so defined that they each normally occur one-fourth of the time; much above and much below normal, one-eighth of the time. Precipitation is depicted in terms of light, moderate, and heavy, each class normally occurring one-third of the time and thereby having equal probability of occurrence. These maps graphically represent only the general trends and give the country's weather picture at a glance. For quantitative studies, where monthly mean temperatures and actual precipitation records are needed for a given time and place, other publications of the Weather Bureau should be consulted. P. R. M.